1917
Prof.
E. Butler.

1918 Botanical Series. Vol. IX, No. I.

Memoirs of the Department of Agriculture in India

THE DISSEMINATION OF PARASITIC FUNGI AND INTERNATIONAL LEGISLATION

BY

E. J. BUTLER, M.B., F.L.S.

Imperial Mycologist

AGRICULTURAL RESEARCH INSTITUTE, PUSA

PRINTED AND PUBLISHED FOR

THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

BY

THACKER, SPINK & CO., CALCUTTA

W. THACKER & CO., 2, Creed Lane, LONDON

Price, Re.

EDITED BY

The Council of the Pusa Agricultural Research Institute.

1916. BOTANICAL SERIES. VOL. IX, NO. 1.

MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA

THE DISSEMINATION OF PARASITIC FUNGI AND INTERNATIONAL LEGISLATION

BY

E. J. BUTLER, M.B., F.L.S

Imperial Mycologist

AGRICULTURAL RESEARCH INSTITUTE, PUSA

PRINTED AND PUBLISHED FOR

THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

BY

THACKER, SPINK & CO., CALCUTTA

W. THACKER & CO., 2, CREED LANE, LONDON

Agents for the Sale of Government Publications.

IN THE UNITED KINGDOM.

Constable & Co., 10, Orange Street, Leicester Square, London, W.C.
Kegan Paul, Trench Trübner & Co., 68-74, Carter Lane, E.C., and 25, Museum Street, London, W.C.
Bernard Quaritch, 11, Grafton Street, New Bond Street, London, W.
P. S. King & Sons, 2 and 4, Great Smith Street, Westminster, London, S.W.
H. S. King & Co., 65, Cornhill, E.C., and 9, Pall Mall, London, W.
Grindlay & Co., 54, Parliament Street, London, S.W.
T. Fisher Unwin, Ld., 1, Adelphi Terrace, London, W.C.
W. Thacker & Co., 2, Creed Lane, London, E.C.
Luzac & Co., 46, Great Russell Street, London, W.C.
B. H. Blackwell, 50 and 51, Broad Street, Oxford.
Deighton, Bell & Co., Ld., Cambridge.
Oliver & Boyd, Tweeddale Court, Edinburgh.
E. Ponsonby Ld., 116, Grafton Street, Dublin.

ON THE CONTINENT.

Ernest Leroux, 28, Rue Bonaparte, Paris.
Martinus Nijhoff, The Hague, Holland.

IN INDIA AND CEYLON.

Thacker, Spink & Co., Calcutta and Simla.
W. Newman & Co., Calcutta.
R. Cambray & Co., Calcutta.
S. K. Lahiri & Co., Calcutta.
B. Banerjee & Co., Calcutta.
The Indian School Supply Depôt, 309, Bow Bazar Street, Calcutta, and 226, Nawabpur, Dacca.
Butterworth & Co. (India), Limited, Calcutta.
The Weldon Library, 18-5, Chowringhee Road, Calcutta.
Rai M. C. Sircar Bahadur and Sons, 75-1-1, Harrison Road, Calcutta.
Higginbothams, Ld., Madras.
V. Kalyanarama Iyer & Co., Madras.
G. A. Natesan & Co., Madras.
S. Murthy & Co., Madras.
Thompson & Co., Madras.
Temple & Co., Madras.
P. R. Rama Iyer & Co., Madras.
Thacker & Co., Ld., Bombay.
A. J. Combridge & Co., Bombay.
D. B. Taraporevala, Sons & Co., Bombay.
Mrs. Radhabai Atmaram Sagoon, Bombay.
Sunder Pandurang, Bombay.
Gopal Narayan & Co., Bombay.
Ramchandra Govind & Son, Kalbadevi, Bombay.
N. B. Mathur, Superintendent, Nazir Kanun-i-Hind Press, Allahabad.
A. Chand & Co., Lahore, Punjab.
Rai Sahib M. Gulab Singh & Sons, Mufid-i-Am Press, Lahore and Calcutta.
Superintendent, American Baptist Mission Press, Rangoon.
S. C. Talukdar, Proprietor, Students and Company, Cooch Behar.
A. M. & J. Ferguson, Colombo, Ceylon.

THE DISSEMINATION OF PARASITIC FUNGI AND INTERNATIONAL LEGISLATION.

BY

E. J. BUTLER, M.B., F.L.S.,

Imperial Mycologist.

A FUNGUS is a minute plant, composed of a vegetative part (mycelium) and seed-like reproductive bodies (spores). It may be disseminated by the mycelium or by spores, and in no other way.

The mycelium is incapable of independent spread for any considerable distance, except in rare cases : it is usually adherent to the substance on which it grows, often immersed wholly or in part in it ; small fragments detached perish quickly ; and larger pieces, which might preserve their vitality, fall to the ground before long when carried into the air. Just as it is well known that in the higher plants the vegetative body is less able to stand extremes of heat and cold or dryness than the seeds, so also in the fungi the mycelium is generally less resistant to such unfavourable conditions than the spores. Laboratory workers who are engaged in the cultivation of living fungi are familiar with this fact. Furthermore the fungi which cause disease in plants are parasites and for the most part cannot long survive in their vegetative condition (unlike the spores) unless able to obtain living food from the plants on which they grow.

Hence, dissemination over long distances in the mycelial condition only occurs when the substance on which the fungus is growing is itself conveyed from one place to another ; in the case of parasites such dissemination is practically confined to occasions when the plants[1] on which they feed are moved, though a few cases, such as facultative soil parasites, may travel with earth

[1] Living plants are taken to include not only complete plants, but also cuttings, buds, tubers, bulbs, seeds, and any other part that can survive detachment from the plant, even (within limits) cut flowers and green leaves. Some parasitic fungi can also survive in a vegetative and often quite long-lived condition on dead parts of plants.

or the like. Nevertheless several instances of extensive spread in this manner are known—

Phytophthora infestans (the cause of the potato blight) has reached practically all parts of the world, in which potatoes are grown, as an internal mycelium within the potato tuber.

The blister-rust of white pines (*Peridermium Strobi*) has been introduced into the United States as an internal mycelium in the stems of seedling pines obtained in vast numbers from Europe.

The mildew of *Euonymus japonicus* survives the winter in Europe as an external mycelium on the leaves, and doubtless came from Japan or elsewhere in this condition, when first introduced into Europe some 15 years ago.

The spores are, however, the usual means of spread. For this they are much better fitted than the mycelium, being often long-lived bodies, able to stand drying or extremes of heat or cold. The spores of bunt of wheat have been germinated after 8 years, and have been kept in a solid lump of ice for 3 months in Canada, without the slightest injury, though the temperature fell to 20° F. more than once. They are more susceptible to heat : bunt spores can be killed by immersing them in hot water at about 130° F. for 10 minutes and yellow rust of wheat in India by 5 minutes in water at about 120°F. ; the dry spores can stand considerably higher temperatures. So far from being injured by drying they can usually be best preserved in a dry condition and it has often been noticed that thorough drying favours their subsequent germination.[1] Owing to their small size also, often approximating to that of very fine dust, they are readily blown about, and as they are usually detached as soon as ripe, air currents play the most important part in their dissemination. Many spores are provided with arrangements for sticking them to objects with which they come into contact. Thus many rusts and smuts have fine spines on the spore wall, the anthracnoses liberate their spores with a mucilaginous substance which is adhesive on drying, the cilia of *Pestalozzia* serve the same purpose, and so on. Not only, therefore, are spores cast into the air in vast numbers,[2] but their small size and tendency to adhere cause them to attach

[1] There are some exceptions to this, as the 'summer spores' (sporangia) of the downy mildews, which are often unable to survive even 24 hours' thorough drying.

[2] It has been estimated that a small spore horn of the chestnut bark disease fungus (*Endothia parasitica*) may contain 115 million spores, a bean pod affected with the bean anthracnose (*Glomerella Lindemuthianum*) may produce from 500 to 1,000 million spores during the season, while *Lycoperdon bovista*, one of the (harmless) puff balls, may contain 7,000,000,000,000, and the common edible mushroom can shed spores at the rate of 40 millions per hour.

themselves to neighbouring objects such as other plants, insects which visit plants, and even the person and implements of people passing through infected fields or working in them.[1]

These properties of the spores render them peculiarly suited for dissemination. For short distance spread, currents of air are unquestionably the most important means in the great majority of cases. The splashing of rain, accompanied by the flapping of wet leaves against one another, is the chief means in a few cases, as in the bean anthracnose, and is a secondary means in others, as in potato blight. Adhesion by contact is well known to cause much of the bunt in wheat, when wind-borne spores or broken bunt balls get into the seed grain. Spread by insects takes place in certain well-established cases, and is highly probable in others. The ergots of rye (*Claviceps purpurea*) and other grasses are carried in part by *Melanostoma mellina*, *Rhagonycha fulva*, etc., which are attracted by the sugary secretion that accompanies the *Sphacelia* stage of the fungus, and carry the spores to other grass flowers. Pear blight, [*Bacillus* (*Micrococcus*) *amylovorus*] begins often in the stigma, to which the bacillus is carried by insects (chiefly bees) from infected sap escaping from the bark in spring. In *Sclerotinia urnula* also the sweet-smelling spores are carried by insects to the flowers of *Vaccinia Vitis-idaea* (cow-berry). In many cases insects which cause wounds allow parasitic fungi to enter ; larch canker may begin from the wounds of *Coleophora lariciella* and *Chermes laricis* ; *Ceratostomella pilifera* (a fungus which causes blueing of the wood of *Pinus ponderosa*) from wounds of *Dendroctonus ponderosæ* and so on ; while the *Nectrias* which cause canker of fruit and forest trees are said sometimes to be conveyed on the bodies of the insects which cause wounds through which the fungi can enter. Occasionally other animals have been accused of disseminating disease ; mice are said to carry the spores of *Fomes annosus*, the cause of a well-known pine disease, and snails those of a fir disease caused by *Cucurbitaria pityophila*. Almost any disease may be carried by farm-workers, but the cases of serious damage from this cause are rare. All soil-inhabiting fungi are liable to be carried by irrigation water or surface wash after heavy rain; *Fusarium* wilts are undeniably carried from field to field by the latter ; and there is evidence in India and elsewhere that diseased sugarcane stems thrown into irrigation channels may enable the spores of the red rot fungus to reach crops growing at a lower level. Infected soil may also carry the spores of

[1] In the Southern States it is said that experience has taught the peril of working in the bean fields attacked by anthracnose on wet days, owing to the way the disease is carried on the person and implements of the workers. We have evidence, too, that the Godavari palm disease in India is often carried by those who climb the trees for the leaves, fruit and for toddy drawing.

the fungi which cause wilt and allied diseases and may reach other fields in various ways, as on the boots of field-workers and pedestrians. But the majority of these and other minor means of dissemination can only be invoked to account for spread over comparatively short distances and may be at once ruled out as probable causes of extension of disease to distant countries. Leaving out dissemination through the air, all the others require the susceptible plant to be within short range of the source of infection. The normal flight of insects, the flow of irrigation water, or the range of labourers and pedestrians, is through a limited area ; and though we could imagine diseases crossing land frontiers or even passing, say, from Ireland to England in this manner, spread to Europe from America or East Asia would be rare indeed.

For such long-distance spread, for what may be called " discontinuous spread," the methods are much fewer. They may practically be reduced to three : dissemination through air ; dissemination by animals that travel long distances rapidly, as migrating birds and certain insects ; and dissemination on plants and other horticultural produce. The relative importance to be assigned to each has not, so far as I know, ever been adequately discussed and exact data for such a discussion are scanty ; yet they yield results of considerable significance.

To take what must be of the least importance first, birds are probably the chief animals that could materially contribute to the discontinuous spread of parasitic fungi. The distances to which they travel are remarkable. Richard's Pipit, which breeds in Eastern Siberia from Lake Baikal to the sea of Okhotsk, regularly visits Europe, as far sometimes as England, and passes through Spain even to Western Africa. Several other Siberian birds visit Western Europe, some, such as the Hooded Crow, in enormous numbers. The Knot, which breeds within the North Polar basin, has been found in winter in Australia and New Zealand. Individually marked storks, which breed in Central Europe, have been identified in South Africa in winter. Still it is perhaps possible to show that they cannot be a serious danger. The wanderings of migratory birds which travel long distances are usually between areas of very dissimilar climate ; they pass in a general direction from north to south and back again ; and between the extremes of their journeys the climates and vegetation are so different that the agricultural and horticultural products are usually sufficiently distinct to have very few parasites in common. Where birds pass through areas with partially similar agricultural and horticultural crops, as from south to north Europe and the southern to the northern parts of North America, the parasites which they could convey would sooner o-

later be able to effect continuous spread by one or other of the methods discussed above ; for the most part they have already done so, where not restricted by deficient powers of acclimatisation, and though migrating birds may have enabled them to pass natural barriers such as the Alps or the Channel more rapidly, the present distribution would probably be much the same even if birds did not exist. The parasites of plants long established in southern and northern Europe are, except in the case of those recently introduced, probably as much identical as they are ever likely to be. Where they differ, the explanation is to be sought in the lesser adaptability to differences in climate frequently possessed by the parasites as compared with their (cultivated) host plants.[1] In general it may be said that England, for instance, is little liable to receive new pests from southern Europe except when they have been recently introduced into the latter area. The danger, in England, is primarily from more distant regions where the climate is not too dissimilar, such as North America and to a considerable extent also temperate eastern Asia, and birds or other animals cannot greatly increase this danger.

There is probably an exception in the case of recently introduced pests. Certain classes of these might be rapidly spread within a large part of Europe by birds. Nothing can reduce this danger but we may console ourselves by the reflection that continuous spread through the same areas would almost certainly occur in any case in the long run, and that the remedy lies in keeping such pests out of Europe altogether, by international co-operation.

Exact investigations of the extent to which birds can actually disseminate fungi seem to be very scanty. In the eastern United States some were examined a short time ago.[2] They were shot, and the beaks, legs, etc., scrubbed, the washings being then used to determine the number of spores. On two woodpeckers, 757,074 and 624, 341 spores, respectively, were found and a high proportion of these were the spores of the chestnut bark disease, which is at present exterminating the chestnut in this area. Some of the birds shot were on their northward migration and could no doubt have carried this disease. Yet it is remarkable that though chestnut blight has been in the neighbourhood of New York since 1904, it had not, up to 1913, been able to cross a chestnut-free belt in the Catskill mountains, some 30 to 40 miles broad, running roughly north and south, parallel to and just west of the heavily

[1] Nothing else will explain the absence of *Phytophthora infestans* in potatoes in the warmer and drier parts of the United States and in the centre and west of India, or of wheat bunt and maize smut in all but the most temperate parts of India.

[2] *Journ. Agric. Research*, II, 1914, p. 405.

infected Hudson River Valley.[1] So far as the spread from east to west is concerned birds can, therefore, have played little part.

The diseases liable to be carried by birds would naturally be chiefly those affecting fruit and forest trees and producing spores on the upper parts of the tree.

Outside birds, the only other animals that might perhaps help to disseminate fungi over large distances are insects. In some cases these have a power of dispersal probably unequalled even amongst birds.[2] That they should carry spores would seem to be a most natural assumption. Possibly they have done so in many cases in the past, and there may now only be a residue of cryptogamic parasites in each land area which, for some unknown reason, is unsuited to dispersal by birds and insects. It is only within comparatively recent times that any record has been kept of the appearance of new fungal diseases in certain parts of the world, and it is quite possible that all or nearly all of these belong to this residue. Since, however, the object of the present paper is primarily a discussion of the means by which parasites hitherto confined to one locality are, at the present time, able to reach areas separated by the ocean or by large tracts with unsuitable host plants, and since there is no evidence that birds or insects are now a considerable agency in effecting this spread, what may have happened in the distant past is not of direct consequence.

A second means of discontinuous spread is through the air. Though it is somewhat difficult to understand why this should not suffice sooner or later to spread most diseases over those parts of the world with suitable climates, yet such evidence as is available points altogether in the opposite direction.

The bulk of the evidence is circumstantial. Direct experiments are few and do not seem to have been framed so as to ascertain how far spores might be carried by the wind in storms or when the spores of, say, oat smut are sent into the air in clouds during threshing. Concordant results have been obtained in Germany and Russia that "spore traps" remained free from smut spores beyond 250 yards from heavily infected fields, though at Pullman, in the United States, the spores may fall copiously at a distance of a quarter of a mile. The area around barberry bushes through which black rust of wheat (which spends part of its life on the barberry) can be disseminated to the wheat is also said to be remarkably low. There are, however, various

[1] *Cornell University Agric. Exper. Stat. Bull.*, No. 347, 1914, p. 545.
[2] Tutt, J. W. "The Migration and Dispersal of Insects," London, 1902.

records in the case of rusts in which there are two hosts, where one appears to have become infected from the other through moderate distances. *Coleosporium Euphrasiæ* seems to reach the islands off the north-west German coast from the mainland[1] and other cases are recorded of the occurrence of one stage of these fungi from 5 to 8 miles from the plant bearing the alternate stage. The general results of the investigations seem to show that the distance to which spores may be carried in the air has often been exaggerated in the past, and that it is much less than might be expected.[2] Even such small bodies fall gradually when in the air and it has been found[3] that the spores of some of the higher fungi fall at the average rate of 0·5—5 mm. per second in still air, and so must come to earth before very long.

On the other hand, it is well established that dust particles (which are of the same order of size as spores) can be carried to great distances under certain conditions. The dust from the volcanic eruption of Krakatao in 1883 travelled thousands of miles, that from Vesuvius and Etna has reached Constantinople, Norway has been strewn with volcanic dust from Iceland. In these cases the dust has been probably thrown up to a great height by the eruption and its lateral spread may be accounted for by this. But dust has also been carried a long way when blown from the ground by storms. From North Africa it is said to have reached a considerable part of southern Europe; while the wind known as the Harmattan, which takes its rise in the Sahara, blows clouds of dust far out into the Atlantic in a south-westerly direction from the Senegambia and Guinea coast. This dust has often fallen on vessels several hundred, and even more than a thousand miles out to sea, and Darwin collected particles of stone, over a thousandth of an inch square, 300 miles from

[1] This and several other interesting cases are quoted by Klebahn ("Wirtswechselnden Rostpilze" 1904.)

[2] I believe a somewhat similar conclusion has been reached by plant breeders with regard to the distance to which pollen grains may be carried by the wind; and the long controversy with regard to air-borne infection in such human parasitic diseases as scarlatina and cholera has ended in the same way. Indeed the whole of our modern sanitary regulations dealing with quarantine and the restriction or isolation of infectious diseases, are based on the view that it is the living carrier and objects, such as clothing, which have come into contact with infected persons, that constitute the danger. Even the long-lived and minute organism of scarlatina is not believed to be carried in the air to more than a very limited distance and did not reach many parts of the world until long after it had been known in Europe. As would be expected the evidence regarding the dissemination of the seeds of higher plants is to the same effect and even the small spores of ferns have not been of advantage to this group in enabling it to colonise distant areas more readily than the flowering plants (H. Christ, "Die Geographie der Farne," 1910).

[3] Buller, A. H. R. "Researches on Fungi," 1909, Chaps. XV and XVI.

land. These would exceed in size and weight the spores of many fungi. It would seem natural to suppose that spores might equally be carried for at least some hundreds of miles, were it not that there is a great deal of circumstantial evidence against this to support the direct evidence mentioned above.

This evidence is based on the known distribution of the minute plants which cause disease. It may be divided into two classes. The spread of a limited number of diseases has been closely observed and has not been found to be such as would be accounted for by long-distance spread through the air. The geographical distribution of some groups of parasitic fungi has also been worked out and seems equally to exclude this possibility in a certain number of cases.

Amongst the diseases whose spread has been closely observed and is evidently not due to their spores having been carried by the wind over large areas, the following examples may be selected :—

The chestnut bark disease has been carefully watched, since soon after it first appeared in the United States. It is quite well suited for wind dissemination, as the parasite liberates considerable quantities of ascospores into the air. Nevertheless its spread has been continuous in the main and, as already stated, it was unable to leap a 30 or 40 mile belt free from chestnuts in the Catskill mountains, at least up to 1913, though a little further south it spread continuously along the southern border of New York State, where there is a narrow strip of chestnuts, and so reached the large chestnut area of the south-west of the State. In the ten years after it was first observed in New York City in 1904, it had spread from New Hampshire to Virginia and as far west as western New York and Pennsylvania, but had not reached Ohio or Indiana. Where "spot" infections (*i.e.*, isolated attacks not due to continuous spread) have been observed, the majority have been traced to the introduction of diseased nursery stock.

The American gooseberry mildew was introduced into Europe about 1900. There were probably at least three distinct introductions about the same time, into Ireland, into Denmark, and into Russia. In 1905, it is known to have extended to six counties in Ireland, to ten widely separated localities in Russia and also to Finland, to Posen in Germany near the Russian border, to Norway and to Sweden. It attracted so much attention

during this period that a close watch was kept for it in the countries hitherto free from it. Yet it was not reported to have reached England until 1906, Austria until 1905 or 1906, Hungary until 1908, Belgium until 1909 or 1910, and France actually not until 1913 (though it has been suggested that France was infected earlier and indeed that the English attack came from France). Had spores from the first outbreak been carried hundreds of miles through the air all the gooseberry-growing countries in Europe would have been equally liable to attack in the first few years. Instead of this we have definite statements that all the early Scandinavian attacks came with plants from a nursery in Denmark,[1] that it was probably distributed all over Austria from a single nursery[2] and that nursery distribution from Denmark and Russia accounts for the whole of the infection of Europe, there being no evidence that Ireland assisted in the spread. Even within England the distribution is not such as would be accounted for by the carrying of the spores for long distances through the air from the first foci of infection in Worcestershire. The fungus is adapted for wind dissemination in so far that it liberates spores freely into the air; and though these spores are not very long-lived, they would doubtless survive the crossing of the Channel or the Irish Sea without difficulty.

Blister-blight has been known on tea in Assam since at least 1868 and is one of the most destructive diseases of the crop. It remained entirely confined, so far as is known, to the north-east corner of Assam until 1908, when it appeared in the neighbourhood of Darjeeling, and spread with alarming rapidity. Though excellently furnished with the means for short-distance spread, it was unable to traverse the gap between north-east Assam and Darjeeling for 40 years, and has not yet entered the still nearer districts of Cachar and Sylhet. It is peculiarly dependent on climatic conditions and has failed to spread continuously along the tea in the middle and lower parts of Assam. It may have reached Darjeeling

[1] Eriksson, J. in *Zeitsch. f. Pflanzenkrankheiten*, XVI, 1906, p. 83.
[2] Hecke, L. in *Naturwissensch. Zeitsch. f. Land-u. Forstwirtschaft*, 1911, p. 51.

in the post or on living plants but can scarcely have travelled through the air, otherwise Cachar, with its similar climate to Upper Assam, would certainly have become infected. Outside the two areas mentioned, it is still unknown, if we except a recent report from Formosa.[1]

The Godavari palm disease (*Pythium palmivorum*) probably first appeared about 1890. Where it came from is not known, possibly from some of the islands in the Indian Ocean, possibly from Malabar where it occurs sporadically and sometimes causes minor epidemics in the coconut forests. In Godavari it spread with great intensity amongst the palmyra palms, killing from 50 to 75 per cent. in many parts. Extension was continuous, the rate being about 1 to 3 miles per annum, and was roughly centrifugal from a point on the Godavari river. Over 1,000 square miles were affected in 1905. But no cases have been found that could have been due to air-borne infection for a distance exceeding a few miles and the immense palm areas to the north and south of Godavari have remained free, except where the continuous gradual extension from palm to palm was going on. The spores are sometimes formed in situations freely exposed to the air and fall off when ripe, but they have evidently not been carried through the air for even a 24 hours' journey.

The downy mildew of the vine is probably indigenous in the United States, where it is common on wild native species and has probably existed for a very long time. It did not reach Europe until 1877, by which time American vine stocks were being imported in considerable quantity to replace the vines destroyed by *Phylloxera*. It was in France by 1878, and in the next year was found in the Rhone valley, in Savoy and had reached Lombardy. In 1880, it was found in Algeria and the Tirol, and in 1881, in Greece. It subsequently spread over all the rest of southern and central Europe, to north Africa and parts of Asia; it was recorded in Australia in 1866-67, but did not extend to Cape Colony until 1907 or shortly before. It is believed to have got to Java, where it was collected in 1905, on fresh grapes brought in by the mail

[1] Sawada, *Bot. Mag.*, Tokyo, 1914.

boats. Had it extended through the air, it is remarkable that it did not begin to spread until the collapse of the European vines led to an introduction of living plants from its original home. From Europe, its wider distribution on exported vines and grapes is easy to understand.

The vine *Oidium* is another American species which spread through Europe progressively after its first introduction. It was noticed at Margate in 1845, and two years later was found in the Rothschilds' greenhouses at Suresnes near Paris. In 1848, it attacked other gardens near Suresnes and appeared in Belgium. In 1849, it was all around Paris and next year was in the Bordeaux district, in Spain and in Italy. In 1851, it was all over France, Spain and Italy and was reported in Switzerland, Hungary and all along the Mediterranean shores. It is now known practically wherever the vine is cultivated. As in the last case the species is native to America and did not spread until introduced into Europe, probably on living vines. If it could be blown across the Atlantic we would expect it to have appeared in a number of places simultaneously and probably at a much earlier date.

The oak mildew is a species allied to the last and, like it, is endemic in North America. It was first seen in Europe about 8 or 10 years ago, but once introduced spread continuously (though exceedingly rapidly) over the whole continent. The *Oidium* on *Euonymus japonicus*, which is probably endemic in Japan, is another similar case, which reached Europe about 1900 and is now all over southern and western Europe. In both these mildews the host plant was available to receive air-borne spores long before the disease appeared, and both were probably nursery introductions. Several other instances of the same kind will be found in the detailed list below (see Appendix I).

Of diseases long known in Europe and more recently introduced into the United States, the carnation rust is a good example. It has been known in Europe since 1789, a time when fungi attracted little notice, so that it may have been present long before. It was not seen in the United States until 1890, when it was found in Michigan. It did so much damage that it is not likely to have been overlooked previously. Another case

is the blister-rust of the Weymouth or white pine. This tree is a native of the east of North America and was introduced into Europe about 200 years ago. In Europe it was attacked by a rust which inhabits the European stone pine (*Pinus Cembra*) but which was unknown in North America. This rust was noticed in Europe at least 50 years ago. Recently a very large trade in seedling pines sprung up between Europe (especially Germany) and the United States, and since 1903 it is calculated that some millions of diseased pines have reached the United States from Hamburg and elsewhere. The blister-rust was found in the United States for the first time on these pines, and has been detected altogether in more than 230 places, in all but one on imported plants. In Europe the pines are infected by air-borne spores from currant and gooseberry bushes (on which the fungus passes part of its life) and if these spores could traverse the Atlantic in the air, the pine forests of America would have been infected long since.

The coffee leaf disease has been found in east and central Africa on wild and semi-wild species of *Coffea*. It occurs as far west in the Congo as at least longitude 23°E., but has not been seen on the West Coast. The disease became known first in the epidemic outbreak in Ceylon in 1868. Since that date it has spread to every coffee-growing country in the East and far into the Pacific; the spread has been gradual and the latest recorded attacks are in the New Hebrides and New Caledonia, which latter colony was reached in 1911. Yet the great coffee-growing areas in South and Central America and the West Indies are free from it, as also apparently the plantations in Australia and Hawaii. If, as is probable, the parasite is a native of East Africa, the home of the chief coffee plant of commerce (*Coffea arabica*), long-distance wind dissemination would be expected to carry it to West Africa where it would have found host plants on which it can grow, and thence to the West Indies and America. Its spread throughout south and eastern Asia and the Pacific is readily explained by trade movements and the introduction of East African and Arabian coffee varieties into the British, French, Dutch, and Spanish colonies. There is probably little such movement across Africa from east to west and the escape of the New World may be

due to the much greater length of time occupied in conveying the coffee seeds or bushes to that part of the world when first introduced, and the comparative rarity of intercourse between the two areas.

The hollyhock rust is an even more striking case of distribution over distant areas before it reached those nearer at hand. It is endemic in Chili and was first collected there before 1831. It is said to have been seen near Melbourne in Australia in 1857 and was certainly collected in 1865. In 1869, it was found in Spain and reached France in 1872 or 1873. In 1873, it was widely distributed in France, had appeared in several places in England and was found in Rastadt in Germany. In 1874, it was all over Holland, in Stuttgart, Erlangen, Nurenberg and Lubeck in Germany, near Rome and Naples and in Denmark. In 1875, it reached the Cape of Good Hope; in 1876, Austria, Hungary and Russia; 1877, Switzerland and Greece; 1887, Sweden; and 1890, Finland. Up to 1886 it was unknown in the United States but in that year it was found in Massachusetts and soon spread to other States. It was, when first introduced to Europe, exceedingly destructive and even now, though less virulent, little liable to be overlooked. Though not well suited for wind dissemination, as its spores are not set free as readily as in most of the other cases discussed, still they are eventually liberated in considerable quantities with fragments of the plant, and if liable to wind dispersal over long distances it is remarkable that the United States should have escaped so long after the fungus had reached Europe and Australia from Chili. It appears to travel really with seed.

The above cases have been given at some length as they are all noticeable or destructive diseases whose spread has attracted attention. In most of them the parasite liberates its spores into the air, sometimes in great quantity but in none that I have been able to find is there the slightest evidence that the spores can cross the oceans borne by the wind. Several suggest that aerial spread is limited to a few miles, while others are capable of bigger jumps, possibly of 50 miles or (oak mildew) even more.[1]

[1] I have purposely left out of consideration whether we can offer any explanation why the spores of a particular disease are not carried successfully over long distances in the air. The problem is, are they carried or not; and if not, the reasons why do not concern us.

Another large group of cases could be selected based on the total absence of specific diseases from certain areas, though long known elsewhere. Particular stress is not laid on these cases, since we do not always know the factors which govern acclimatisation to a new locality, and have some reason to believe that they are often more restrictive in their effects where parasitic fungi are concerned than in respect to the host plants. It seems better, therefore, to rely more on cases like those quoted above, where subsequent experience has proved that the more or less prolonged absence of a disease from a certain locality was not due to any want of ability on the part of the parasite to live in that region when introduced.

One of the most remarkable of this group of cases is the absence of the common yellow rust of wheat (*Puccinia glumarum*) from North America, Australia, and South Africa. The other two wheat rusts (*Puccinia graminis* and *Puccinia triticina*) occur practically wherever wheat is cultivated, though in India, *P. glumarum* has actually a wider range than *P. triticina*. Why yellow rust, which stands the extremes of climate in all the wheat-growing parts of India well, should fail to attack wheat in the United States, Australia or South Africa is a mystery, unless indeed we accept the simple explanation that its spores have not yet reached these areas.[1]

The lilac is attacked by two diseases of restricted distribution. In Germany and Holland a blight caused by *Phytophthora Syringæ* has been prevalent during the past few years; in the United States a mildew (a form of *Microsphæra Alni*) is very abundant on it; neither of these have been recorded elsewhere, at least up to 1914 for the former and 1908 for the latter.

There are two serious diseases of tobacco in the Dutch Indies. One, the bacterial disease caused by *Bacillus solanacearum*, attacks several other plants, including the potato. It is of very wide distribution in most tobacco-growing countries of the world and can readily be conveyed in potato tubers and on other living plants. The other, caused by *Phytophthora Nicotianæ*, is not known on anything but tobacco and has not extended beyond the Dutch Indies. It is probable that living tobacco

[1] Since the above was written yellow rust of wheat has been reported in the United States (*Phytopathology*, VI, 1916, p. 96). The area affected is as yet limited, and it is probably a recent introduction.

plants are never exported, and in the absence of this means of spread, the latter fungus has failed to reach other countries. It has two spore forms, one suited admirably for wind dissemination but only capable of living for at most a few weeks ; the other long-lived and resistant but only set free in the soil when the diseased plants decompose.

Many other cases similar to these could be instanced, belonging to every group of fungi and with every type of spore. It is difficult to believe that they can all be due to deficient powers of acclimatisation, and many of them are probably to be accounted for by the limited distances to which the spores can be carried in the air in a living condition.

Of the large groups of fungi whose geographical distribution opposes the view that living spores can be borne for long distances in the air, the rusts afford some intresting examples. In the genus *Uromyces* there are 119 species in Europe, of which 70 are endemic (recorded up to 1911). Yet of these Europe has only transmitted three (*Uromyces Betæ*, *U. caryophyllinus* and *U. Trifolii*) to North America, while two (*Uromyces striatus* and *U. Fabæ*) are doubtful. In turn we have only received a single species (*Uromyces appendiculatus*) from North America, though the genus is very well represented there and no less than 249 species have been recorded in North and South America combined, of which 221 are endemic. It is worthy of note that all the exchanged species are parasitic on cultivated plants. Australia, which has 32 species, of which 22 are endemic, has only received six from outside and these six are the same as those which have traversed the Atlantic.[1] Another rust genus, *Phragmidium*, which is parasitic on plants of the N. O. *Rosaceæ*, is also of interest in its distribution. Over 60 species are known, but none are endemic in South America (though there is one in the Falkland Islands) and only one has been introduced, *Phragmidium disciflorum* on roses.[2] Though there are many species in southern and eastern Asia, only 4 (or perhaps only 2) are known in Australia and only one of these has been introduced, the same one as to South America, also on roses. These rusts are not, so far as is known, more exacting than many other parasitic fungi in their climatic or other requirements ; their spores are numerous and the least resistant type can often live for several weeks, while the durable spores, that are set free as the host plant withers (or sooner in *Phragmidium*), live for months ; and though they are strictly parasitic and

[1] The above details are mostly on the authority of P. Dietel (*Ann. Mycol.* IX, 1911, p. 160) who has given special attention to the geographical distribution of rusts. McAlpine (1906) gave a seventh species (*Uromyces Polygoni*) as having been introduced into Australia.

[2] Dietel, P. in *Ann. Mycol.*, XII, 1914, p. 93.

confined to definite hosts, this would not be sufficient to account for so markedly restricted a distribution if they were capable of wind dissemination for long distances.

From this consideration of the evidence available the conclusion to be drawn is that in devising methods to prevent the introduction of new diseases of the type of those contained in the detailed list attached (which includes a considerable proportion of the destructive diseases introduced within the 70 or 80 years during which we have reliable records, and represents practically all the classes of parasites likely to spread extensively in the future) infection by spores carried through the air from remote centres is not a contingency which needs to be taken seriously into account.

There remains the third method of the discontinuous spread of parasitic diseases which depend on spores for their transmission—dissemination on plants and other horticultural produce. The recognition of this as an important means dates from a comparatively recent period and it is doubtful if it is even yet fully realised.

There is an abundance of evidence, both direct and indirect, that the spores of most of the great groups of fungi are readily transmitted in a living condition, from one part of the world to another, on plants or parts of plants.

All economic mycologists have probably had direct experience of the transmission of living spores on plants or parts of plants ; many use it as a means of exchanging material for study with more or less distant countries. I have personally sent Indian parasitic fungi to workers in Europe, through the post, with success on several occasions. The infective powers of the mildew of wheat in India have been compared with that in England by means of living ascospores, thus sent on withered wheat stems, and several of our Indian wilt parasites of the genus *Fusarium* have been sent for purposes of study to Berlin on the roots and base of the stem of their host plants. I have also found living spores of two parasites of sugarcane on cuttings of American varieties of cane received at Pusa from Louisiana, through the United States Department of Agriculture, for trial in India. Quite recently I have received from the same Department cultures on sterilised cotton stems of the American cotton wilt *Fusarium*, and found the spores still living after the long journey to India. Indeed cultures of fungi on nutrient material are now sent out all over the world and there is a central bureau in Amsterdam for the supply of such cultures ; a parasite on its host plant is very often in at least as favourable circumstances for travelling as under these conditions. Presumably because of its very familiarity few seem to have thought it worth while to record their

experiences in this direction, but it is unnecessary to labour what probably all mycologists would consider a well-known fact.

Of cases where the importation of plants has been followed by the appearance of fungi conveyed by them to a new locality there are many. None are of greater interest than those disclosed by an enumeration of the fungus flora of the great botanic gardens, such as those of Kew and Berlin. In these gardens a number of foreign species appear from time to time and are unquestionably introduced on plants purchased or presented from abroad and on their packings. Kew, for instance, has a much larger recorded fungus flora than any other area of its size in the world. In the same way parasitic fungi are introduced with foreign varieties of plants by experimental farms and departments of agriculture. In Australia two grass rusts appeared for the first time on the young plants grown from seed imported by the Victoria Department of Agriculture from the United States.[1] In India the only occasion on which the crown rust of oats has been seen was at Pusa, shortly after the experiment farm was started and when Canadian oats were being tried. The race of the parasite *Melampsora Lini* which grows on cultivated flax has also only once been recorded in India, on an experimental crop of recent introduction in the Nilgiris, while on the other hand, the race of the same parasite which grows on the botanically allied linseed and which is common in India, is said to have reached Australia with seed from Calcutta.[2] Nurseries and florists' establishments must have played a considerable part in disseminating fungi of all sorts, from the very nature of their trade. Settlers, planters, and missionaries have doubtless also been responsible at times for the introduction of fungi on imported plants and other agricultural produce.

It is, however, when we come to consider the spread of specific diseases of economic plants, that the close connection between their movements and those of the living plants on which they are borne, becomes most evident. Many instances will be found in the detailed list below and only a few need be referred to here.

> The group of vine diseases of North American origin, the appearance of which was the outstanding feature of the history of viticulture in Europe during the nineteenth century, followed on the shortening of the voyage between the two continents due to the introduction of steamships, and two of the worst, the mildew

[1] McAlpine, D. "Rusts of Australia," 1906, p. 43.
[2] *Agric. Gaz. New South Wales*, II, 1892, p. 157.

and the black rot, are ordinarily held to have been introduced on American vine stocks which were extensively imported during the struggle against *Phylloxera*. The mildew is common but only moderately destructive on the wild American grape vines; against black rot, too, some of the American species, such as *Vitis rotundifolia*, are highly resistant; while the oidium has never been known in America to cause such appalling losses as it did in France from 1852 to 1854, when it reduced the yield to one-tenth or one-twentieth of the normal. But for 300 years all attempts to acclimatise *Vitis vinifera* in the United States failed, and it was only by improving the native species, which resist these local diseases, that success in viticulture was ultimately attained.

The great coffee "boom" in the East during the second and third quarters of the nineteenth century led to the rapid extension of cultivation of the bush throughout all the eastern colonies of European states. It is practically certain that this was accompanied by some importation of the berries from the older coffee-growing localities, such as Arabia and possibly east Africa, where (in the latter at least) the coffee leaf disease was probably long established, as it has since been found widely distributed on indigenous east African varieties. The first recorded outbreak was in Ceylon in 1868, and the following are the dates in which it was found elsewhere:—Mysore 1869; Sumatra and Java 1876 (when was still confined to the western part of Java); Natal probably 1878; Fiji Islands 1879; Mauritius about 1880; Réunion 1882; Philippine Islands 1885; Madagascar before 1886 (said to have been first introduced by a Ceylon planter in 1872 or 1873, during a visit to examine into coffee-growing in that Island)[1]; Tonkin 1888; Malaya and Borneo reported in 1888; Samoa 1894. Owing to the commanding position of the Ceylon industry it is probable that most of these places were infected from that colony; thus it is said to have reached Samoa direct from Ceylon,[2] and the Fiji Islands seem to have been infected by means of a box of seeds packed in earth, received from the same source

[1] Fauchère. *L' Agric. Prat. d. Pays Chauds*, 1907, p. 509.
[2] Reinecke, F. *Tropenpflanzer*, VI, 1902, p. 632.

early in 1879.[1] It has been proved that the uredospores can live long enough to stand such journeys, as they have been germinated in Germany after coming from Mauritius through England. Spore production is very copious and all parts of the plant, as well as the ground and packings, would readily become contaminated on an infected estate.

Citrus canker (*Pseudomonas Citri*) was introduced into the United States about 1912, when it was first seen in South Alabama and Florida. It came from Japan on stocks of Satsuma orange or *Citrus trifoliata*. Its dissemination throughout the Gulf States, where it is at present causing considerable alarm, was effected on nursery stock, perhaps from centres in Texas.

The chrysanthemum rust reached Australia in 1904 on cuttings imported from England. It was carried in the uredo stage, which alone occurs in England, and only this form had been found in Australia when McAlpine published his "Rusts of Australia" in 1906. Probably it owes its spread from its original home in Japan entirely to the trade in living plants. Cuttings have also been accused of carrying several other diseases.

Probably a large number of parasitic fungi can be carried on the seed of their host plants. A packet of purchased seeds examined in Kew some years ago was found to contain spores of several of the diseases of the plants to which the seeds belonged.[2] The leaf spot of celery is spread largely by the use of infected "seed," not less than 90 per cent. of samples of commercial celery seed examined having been reported from Wisley to be contaminated in 1914.[3] The hollyhock rust is another example. It has been proved capable of living through the winter on the persitent carpels, etc., around the seed. Oats are said to have carried the crown rust of this crop to Ecuador and the introduction of the same disease to Pusa has already been referred to. Straw packing is, however, an alternative possibility in this case.

[1] Thiselton-Dyer, W. T. *Q. J. M. S.*, 1880, p. 119.
[2] Massee, G. "Text-book of Fungi," 1906, p. 221.
[3] Chittenden, F. J. "A note on celery leaf-spot-disease," *Ann. Applied Biology*, I, 1914, p. 204.

The fungi which cause rotting of ripe fruit are readily conveyed on consignments of fruit. A recent case reported[1] was on oranges from Brazil, the sea passage being about 18 days. Other cases known are on pineapples and bananas from the West Indies and citrus fruits from South Africa.

The diseases of such crops as cacao and rubber, the cultivation of which has been started in many tropical countries in comparatively recent times, should furnish interesting instances of the spread of fungal parasites through the agency of man. Rubber is often sent considerable distances as young cut-back plants, known as "stumps," and the first Para-rubber sent to Ceylon and Singapore from Kew in 1875 was in the form of seedlings. In cacao also the large fleshy pods would be an excellent medium for conveying living fungi. Unfortunately we are as yet by no means fully acquainted with the parasites of these crops in different countries and several of their worst diseases are caused by species which attack a number of other plants and which there is no reason to think are introduced. The canker fungus, however, is only known on these two crops (and possibly the bread fruit), and as it is now found in most countries of both the eastern and western hemispheres where they are grown, it seems to be highly probable that it has travelled with the host plant.

There are several diseases that from their very nature are unlikely to be carried in any other way than on their victims, in soil, or in packing. The warty disease of potatoes is a case in point; if we could keep potatoes from infected localities out of those still free, it is scarcely possible that the fungus could spread more than a very limited distance indeed. This is because the spores are confined to the tubers and are only set free into the soil when the latter decompose. The finger-and-toe disease of turnips, cabbages, etc., is a similar case; it is still unknown in India, though reported in Ceylon as an introduced disease. Other instances are the diseases of lucerne caused by *Urophlyctis Alfalfæ* and the grass disease caused by *Cladochytrium graminis*. The latter disease was recorded in Great Britain for the first time in 1908 and appeared in every instance where portions

[1] Rushton, W. in *Ann. Applied Biology*, I, 1915, p. 365.

of a consignment of Continental grass seed had been sown. The parasite was found in the seed-coats of 5 per cent. of the seed that had produced a diseased crop and was clearly introduced in this manner[1]. The Harper Adams Agricultural College has reported a case where a single consignment of potatoes from a crop infected with warty disease, spread the disease over a district with a 5-mile radius.

How far packings are responsible for carrying the spores of parasitic fungi is uncertain. Smut spores would no doubt travel readily in this way, but most of the destructive diseases of this class are already widely distributed and they would be carried still more easily as a rule on seeds. Soil is unquestionably dangerous, as many soil-dwelling parasites are long-lived and resistant to unfavourable conditions. But in a general way there does not seem to be sufficient evidence available to decide how far dry packings can serve as a means of transit for parasitic fungi.

An analysis of some of the Australian rusts to show the probable means of introduction of foreign species to a geographically isolated part of the world may help to an estimation of the part played by man in disseminating parasitic fungi by means of their transmission on plants or packings.

In Australia, 90 species of *Puccinia* had been recorded up to 1905. Of these 22 were considered by McAlpine (" Rusts of Australia," Melbourne, 1906) to have been introduced. I have classified them as follows :—

Thirteen are on cultivated agricultural or horticultural plants, presumably introduced by settlers, gardeners or the trade.

P. Chrysanthemi on chrysanthemum.
P. Cichorii on chicory.
P. graminis, *P. triticina*, *P. simplex* } on wheat and barley.
P. Helianthi on sunflower.
P. Lolii on rye grass.
P. malvacearum on hollyhocks, etc.
P. Maydis on maize.
P. Menthæ on penny-royal.
P. Pruni on peaches, plums, etc.

[1] Massee, G. *Kew Bulletin*, 1913, p. 205.

P. purpurea on sorghum.

P. Thuemeni on celery.

Two are on grasses imported by the Department of Agriculture, Victoria, from the United States, in 1903, the rusts first appearing in December to March, 1903-1904.

P. Impatientis on *Elymus condensatus.*

P. Beckmanniæ on *Beckmannia erucæformis.*

Three are on field grasses and probably came with the seeds of their hosts, in grass packing, or were introduced by settlers.

P. Anthoxanthi on *Anthoxanthus odoretum* (sweet vernal grass).

P. Festucæ on *Festuca ovina* and *F. rigida* (fescues).

P. poarum on *Poa annua.*

One (*P. Cyani* on cornflower) is on a garden flower and field weed and was probably introduced by florists, but may have come in packing.

One (*P. Arenariæ* on chick-weed) probably came with the seeds of its host in packing.

While **two** are doubtful, *P. Prenanthes* on *Lactuca* sp. and *P. Hypochoeridis* on *Hypochoeris radicata* and *H. glabra.*

The genus *Uromyces* is the second largest Australian genus of the rusts. Dietel[1] says that of the 31 species recorded up to 1911, five have been introduced.

U. Fabæ on beans (*Vicia Faba*).

U. appendiculatus on cowpea.

U. Betæ on beet and mangel.

U. caryophyllinus on carnations.

U. Trifolii-repentis on clover.

These are all on cultivated plants whose introduction can be readily understood. McAlpine gives *U. Polygoni* on knot-weed as well, and thinks this might easily be carried with the seeds in straw-packing or in hay. More recently[2] *U. striatus* on lucerne has been found and doubtless came in with imported seed from Europe or America.

To sum up this discussion of the three principal methods by which the "discontinuous spread" of parasitic fungi, which rely on spores for their transmission, may be effected, the evidence available from cases sufficiently

[1] *Ann. Mycol.* IX, 1911, p. 160.

[2] Second Report, *Bureau of Microbiology*, N. S. W., 1912.

recent to have been recorded, points to the preponderating part played by man. Probably at no period in the history of the world has the movement of plants of economic worth, to and from distant countries, been carried on so extensively as at the present day. The time taken in transit has been continually shortened since the introduction of steam; and whether the parasite is best fitted to travel as spores or as mycelium, there is no doubt that there are few parts of the world that have not been brought near enough to allow the great majority of the fungi that cause disease to reach us, with their host plants, in a living condition.

For continuous or short-range spread, parasitic fungi make use of a number of different methods, the chief of which have already been enumerated. Few travel in the mycelial stage, most having spores suitable for the purpose. In a general way these spores are disseminated chiefly by the wind, but each case must be considered individually, as there are some quite unsuited for air transit and no general statement would cover all groups. For discontinuous or long-range spread, on the other hand, the parasites, whether they travel in the mycelial condition or as spores, are bound up with the movements of their host plants, and the general statement may be made that if we can secure the absence of parasites from imported or exported plants, we can control the discontinuous spread of the great majority of parasitic diseases.

With these conclusions in mind, the possibility of controlling the dissemination of diseases caused by parasitic fungi may be considered. Three cases may be distinguished: (1) where the disease has succeeded in gaining a footing in the country; (2) where it has only reached neighbouring countries not separated from us by natural barriers; (3) where it is still confined to areas isolated by the ocean or by large tracts with dissimilar climate and vegetation.

Diseases already present in the country can ordinarily make use of the methods of continuous spread, which are mostly uncontrollable. There have been attempts in the past (and several are in progress at the present moment), to exterminate newly introduced parasites in various parts of the world. It is doubtful if any have succeeded, while some, such as the campaign against black rot of the vine in France and coffee leaf disease in Fiji, have failed completely. The American gooseberry mildew is still spreading in England, in spite of restrictive measures. The Godavari palm disease campaign has been more successful, for it has kept the attack confined practically to the same area, but it has, so far, failed to stamp it out within that area. In the United States very active measures are at present in force against several

diseases of recent introduction, such as citrus canker and the blister-rust of the white pine. In Ireland one of the most hopeful efforts as yet undertaken is directed against warty disease of potatoes, which was introduced into one small area. On the whole, though it is as yet too soon to speak definitely, it is clear that treatments of extinction are extraordinarily difficult to apply successfully, and that it would be much easier and more effective to keep the disease from getting a footing in the country.

Against the second class of cases, where the disease has not yet reached us though known in neighbouring countries, India is peculiarly well situated. It is almost completely isolated by the sea or the impassable barrier of the Himalaya. Only along the coastal tracts around the Bay of Bengal and possibly through Baluchistan are there routes by which continuous spread might occur, and there are few cultivated plants which extend along these tracts between India and the countries outside. From Ceylon we might perhaps get infected, as it is possible that such agencies as the wind or contaminated insects could carry spores across the narrow gap from that colony. With these exceptions, however, India is practically immune from foreign diseases unless they are allowed to come in on their host plants. Such countries as are not geographically isolated from their neighbours are in a less favourable position, since they are exposed to attack by parasites that can use the methods of continuous dissemination and there is, as a rule, little chance of keeping these from spreading across the frontier, except in the few cases, such as warty disease of potatoes, where the parasite cannot ordinarily travel unless on its host.

The third class includes all those diseases which can only reach us by the methods of discontinuous spread, which, from the evidence given above, may be practically reduced to dissemination with horticultural produce or packings. If all imports of plant produce could be checked there would be little chance of such diseases entering the country.[1] So drastic a measure is not required provided that we can ascertain what diseases should be guarded against. For this it is important to know: (1) from what parts of the world we might receive dangerous diseases and (2) what diseases exist in each area that could be imported and might prove injurious.

There is no direct evidence to indicate from what parts of the world India might import dangerous diseases. The country is so large, the variations of

[1] It is scarcely necessary to mention that fungus diseases can escape detection and disinfection at the port of entry, in so many cases, that this method of attempting to obtain security has been abandoned.

climate are so great and there are so many different crops grown, that there is scarcely any considerable area without some parasite liable to attack a valuable economic plant in India. Further there are as yet few exact records of introduced diseases to suggest where danger may be looked for. We have probably received the potato blight and vine mildews from Europe ; chrysanthemum rust may have reached us direct from Japan or through Europe, the downy mildew of maize (*Sclerospora Maydis*) perhaps from Java, and that of cucurbits possibly from Ceylon. Most of the recently introduced diseases in Europe seem to have come from North America, East Asia or the temperate parts of South America, but no such well-defined danger zones can be suggested for India. Hence in order to secure ourselves against the introduction of exotic diseases, there seems to be no alternative at present but to take each of our important economic plants and examine the records of the parasites that attack it in other countries and that are not yet known in India. In this way it may be possible to draw up lists of the dangerous diseases that should be prevented from entering India on their host plants. Fortunately India is as yet largely self-contained as regards seed supply and nursery produce; comparatively few living plants or parts of plants are imported ; and from the lists furnished by the Customs authorities it would appear to be a fairly easy task to decide what produce enters the country, through private agency, of a kind likely to bring in dangerous plant diseases.

In preparing a list of the diseases that should be guarded against, certain difficulties arise. In the first place the diseases that occur in many countries and colonies are not well known. Even in Great Britain no complete plant disease survey has been made and it is consequently sometimes difficult, or even impossible, to ascertain whether a particular disease occurs in that country or not. This is still more the case with other areas, such as China, from which there may be a danger of diseases being imported into India. In most of the discussions on international problems of phytopathology in recent years, reference has been made to the need for establishing a plant disease survey in each country. At the least a card index should be maintained in some central location, in which all diseases of economic plants are entered under the parasite and under the host plant ; and all new diseases should be recorded as they are reported, together with the localities affected as far as known. The maintenance of an index of this nature requires no great amount of work and enables any country desiring it to receive a list of the diseases and the plants affected which would greatly help it in deciding what imports should be kept out. Only one word of warning is necessary. Such an index cannot be prepared in the laboratory or office alone ; the knowledge required must be gained

largely by "field" work, as it is generally useless to rely on the chance notification of diseases; and the "field mycologist" is the only person who can undertake this work.

Then in deciding whether a disease is likely to prove dangerous or not the problem of variation in virulence in different localities has to be taken into account. There is unfortunately abundant evidence that diseases that are relatively mild in one continent may prove exceedingly virulent in another.

The vine mildew and oidium are cases already referred to above. The chestnut bark disease, perhaps the most completely destructive fungus disease at present under observation, is another, since in its original home in East Asia it is comparatively innocuous. That a parasite introduced to a new home, where conditions are to its liking, may develop accentuated virulence is now well known; the rule holds equally for animal diseases; and small-pox, for instance, is known to rage with exceptional violence when first introduced into a new community, as amongst the North American Indians. An American phytopathologist[1] has recently brought together some cases observed during a tour in Europe of diseases whose destructiveness differs in the two continents. He found the brown rots of fruit (*Sclerotinia* or *Monilia*) did much more damage in Europe than America, as also the strawberry mildew and some others. On the other hand, the black rot of apple (*Sphæropsis malorum*) does little injury in Europe (where it is known from Italy to England) while it is a wide-spread and destructive disease in the United States, and this is true also of the bitter rot of the same fruit (*Glœosporium fructigenum*) and asparagus rust. While it is tempting to think that these differences are due to the diseases being comparatively recent introductions to the country in which they are most destructive (as is true of the asparagus rust), there is no evidence whatever that this is the case with the brown rots, the strawberry mildew or the two apple diseases. Whatever the causes, the fact remains that the virulence of a disease in one continent is no safe guide to its destructiveness if introduced into another.

The preparation of lists of diseases which it is desired to exclude from each country, was accepted as an essential part of the scheme for securing international co-operation in checking the spread of plant diseases and pests, drawn up at the International Phytopathological Conference held at Rome in February, 1914. The object of the Conference was to frame a Convention to control the inter-state circulation of horticultural produce. The meetings

[1] Shear, C. L. "Some observations on phytopathological problems in Europe and America." *Phytopathology* III, 1913, p. 77.

were attended by delegates of some 30 States and Colonies, and the Convention, as finally drafted, secured unanimous support, subject to ratification by the Governments of the countries concerned. The outbreak of war has delayed ratification in most cases and as some differences of opinion regarding certain clauses of the Convention were becoming apparent in several countries,[1] it is doubtless an advantage that further time has been gained for discussion. Since the question of the adhesion of India is not yet decided, it may be useful to examine the leading features of the Convention in the light of the conclusions arrived at in the earlier part of this note, for it is evident that any restrictive measures of the kind proposed should be based on the known facts regarding the dissemination of plant parasites.

The Rome Convention (See Appendix II) proposes to control the inter-state circulation of horticultural stock (living plants, cuttings, grafts, flowering bulbs and cut flowers), with certain exceptions mentioned below. Each adhering State pledges itself not to admit such stock without a certificate that its sanitary condition is satisfactory and also (where required) that it is free from certain specified diseases.

In order to be in a position to grant such certificates, each State undertakes to set up a Government Service of Phytopathology, the duties of which will be to supervise nurseries and other establishments engaged in trade in living plants (with the exceptions referred to) and to inspect cultures or consignments (or both) intended for export.

There must be one or more Government research centres in each country; the appearance of diseases and pests and the localities infected ought to be recorded (but this information need not be notified to other adhering States); measures ought to be taken to prevent or check plant diseases; and there ought to be control of the transport and packing of the plants destined for export that come under the Convention. Each State must take legislative and administrative steps necessary to give effect to these requirements and to punish breaches of the regulations.

To enable each adhering State to know what specific diseases must be mentioned in the certificates given within that State to nursery stock intended for export, every adhering country will prepare a list of the diseases against which it wishes to guard itself. These lists will all be furnished to the Government Phytopathological Service of each country, and when a consignment

[1] See *Gardeners' Chronicle*, 3rd Ser. LVI, 1914, pp. 94, 338, 350; *Proc. 3rd International Congress of Tropical Agriculturs*, London, 1914, pp. 109-117 & 388-391; *Trans. ib.*, I, 1916, p. 125. *Ann. Applied Biology* I, 1914, p. 113; *Journ. Economic Biology*, X, 1915, p. 42.

goes out of any adhering country, the certificate with it must state that it is free from such diseases (mentioned by name) as are on the list of the country to which the plants are going, and which could be in the consignment.

No country may put on its list common diseases already widely distributed, or those whose ordinary host plants are absent from the country. The diseases mentioned must be (1) of an epidemic character, (2) destructive or at least very harmful, and (3) easily disseminated by living plants or parts of living plants.

The Convention does not apply to the vine,[1] to seeds, to edible tubers, bulbs, rhizomes, and roots, to fruits and vegetables, and to roots and produce of field cultivation. Living plants of any kind are also excluded from control if intended for scientific institutions authorised by Government to introduce plants for scientific study. It is clear, therefore, that no certificate is required by the Convention with imports of any of these.

What is not clear is whether a certificate is required with imports of wild plants or plants not coming from a nursery. Article 5 of the Convention states that the adhering countries pledge themselves not to admit living plants without a certificate (except as noted in the last paragraph). The fact that countries such as England import for horticultural purposes wild plants from parts of the world whence certificates cannot possibly be got (as Tibet) was either overlooked, or it was intended that such imports should cease, or it was intended (but not expressly stated in the *Acte Finale* of the Convention) that wild plants should be altogether excluded from the regulations.

There is nothing in the Convention to prevent countries making any other regulations they like, provided they do not constitute a breach of the principles of the Convention. The latter stipulation is not expressly mentioned but, I take it, is implied in any international agreement of the kind.

These are the essential parts of the Convention. Their effect on India may be considered (1) as concerns imports, (*a*) from adhering countries, (*b*) from non-adhering countries, (2) as concerns exports.

The trade in importing plants seems to fall into two main categories: plants already in wide cultivation are imported chiefly from nurseries; plants not already in wide cultivation (including novelties and wild plants) often do not come from nurseries or trade establishments at all.

For the first class, the application of the Convention to imports from adhering countries presents few difficulties, and the mycological requirements

[1] Covered in part by the Berne Convention.

should not cause more restriction in the trade than is likely to be profitable to the trade itself in the long run. All imports of the sort covered by the Convention must have a certificate, whether there are any listed diseases that could be carried or not. This certificate will guarantee that the nurseries from which the plants have come are subject to inspection and that either the crop or the particular consignment (or both) are in a satisfactory sanitary condition. In addition, the Indian list will show what specific diseases (if any) the consignment must be certified free from. The exporting nursery or nurseries will be inspected and if clean from the specified diseases (if any) and the produce or consignment in a healthy condition, the certificate will be given. All that is necessary is for the Indian list to be prepared in such a way that no disease will figure on it which is likely to be so widely present in the exporting country that there will be a difficulty in getting clean certificates, unless India is prepared to stop the import of the host plant from that country. If we wish to continue to import pears from countries in which pear blight is widely prevalent, this disease should not figure on our list. It must not be forgotten that the Convention is drawn up in the interests of the adhering countries themselves and it would be for the Department of Agriculture to consider whether the country is likely to lose or gain by listing a particular disease. In some cases it may be better to keep a disease outside the Convention and to deal with it in a more elastic manner, if necessary.

Imports of nursery stock, of the sort covered by the Convention, from non-adhering countries must cease, unless the exporting country can and will give certificates signed by " competent official agents " in the same form as those required from adhering countries. The adhering countries undertake not to give non-adhering countries more favourable treatment than those adhering. The effect of this part of the Convention is to enable pressure to be brought on other States by the adhering countries and will presumably result in forcing all that have important export trade of the sort mentioned, with adhering countries, to enter the Convention. In the beginning there will be difficulties but they will probably disappear as soon as exporting countries realise where their interests lie.

For plants which do not come into India from nurseries, the difficulties are much greater. As already pointed out it is not clear whether we must refuse admission to all living plants (with the exception of those specifically excluded from the Convention) unless they have a certificate. If so, then we should refuse entry to orchids, flowering bulbs and the like from many tracts outside the British Indian Customs frontiers, including much of the Himalaya,

since it is generally impossible to obtain a certificate in such cases. It seems incredible that this could have been intended and probably plants not coming from nurseries or other trade establishments, and therefore not capable of carrying a certificate (since only nurseries and the like are to be inspected) are meant not to be covered by the Convention at all. If this interpretation is wrong (and the point should be made clear as soon as possible) the Indian Customs will be confronted by a most difficult problem, since it seems impossible to close our frontiers to such plants, and every effort should be made to get the Convention abolished and a new one set up, to which India can adhere. There is little danger to be feared from the wild plants that enter India from the Himalaya and other neighbouring trans-frontier tracts, and standing out may render us liable to heavy penalties from adhering States.

There seems no need to go into the legislative and administrative measures that will be required to deal at the points of entry (which must be specified) with imports under the Convention. Some are laid down in the Convention, others are matters of internal administration. There may be difficulties in deciding who is to bear the cost of consignments refused admission, but such questions are outside the scope of the present discussion.

For the effect of the Convention on exports, much will depend on the modesty of the requirements of other adhering States. The Convention lays down that the lists prepared by each country, of the diseases which it wants to exclude, should be as limited as possible. But, since each country will have a separate list, the total number of diseases which must be watched for in an exporting nursery may be considerable. It will be necessary to scrutinise the lists of the various countries with care to see that they come within the bounds prescribed by Article 10. Even so, there may well be listed diseases which are so prevalent in India that a clean certificate will be difficult to get. As I have already suggested, in some cases it may be wise to attempt to get other countries to withdraw a particular disease from their lists, so as to be able to deal with it in a more elastic manner. Still as a general rule it will be better to have the specific diseases of Indian plants listed by the countries we export to, as they would then be bound to accept our certificates in any case in which they might be correctly given. Although the Convention does not prevent an adhering State from making other regulations, it does, I assume, prevent any regulation which would nullify its provisions. Hence no adhering State could well refuse admission to a properly certified consignment from another adhering State, since this would be to go behind the central principle on which the Convention was based.

The inspectors of the Indian Government Phytopathological Service will have the complete lists of all adhering countries. When a nursery wishes to export stock which comes under the Convention, it must apply for inspection. Presumably it will be necessary for Government to maintain a list of the inspected establishments, and any wishing to export to adhering countries must apply to be placed on this list. It will then be inspected.

The Convention leaves it open whether the inspection is to be made on the growing crop or on the consignment for export or on both. The double inspection was proposed but was judged difficult to apply in some cases. It was also stated in the discussions that inspection of consignments need not be parcel by parcel but that the whole stock which is to form the consignment may be inspected at once.

Not only must the stock (whether growing or ready for export) be inspected for the diseases in the list of the country to which the consignment is going, but its general sanitary condition must be pronounced satisfactory. It is open to the inspecting staff to interpret this latter requirement loosely or strictly, but it is certain that no consignment can safely be pronounced absolutely free from every disease, and the interpretation should, in my opinion, be a broad one. Well kept gardens need not fear it, unless they are struck by an epidemic or something of the kind, when they must expect their exports to be restricted.

To be effective a single inspection in the course of the year will frequently not suffice. As proposed at the Conference (but not adopted) it would be of advantage to inspect the crop at the period of its growth when diseases are most evident (usually as it approaches marketable condition) and also to inspect the consignment when ready for export. It was clearly with a view to making the conditions of inspection as little onerous to the grower as possible, that the double inspection was not insisted on. It seems to have been admitted that as a general rule it is better to examine the consignments ready for export but that in certain cases one must be content with the examination of the crop. From the strictly mycological point of view the examination of the crop can be of great assistance, and if made shortly before the despatch of the consignment would frequently suffice. If made much before the plants were reaching saleable condition, or any considerable time before they were lifted, I would consider a subsequent examination during the period of their preparation for export to be necessary.

In addition to the visits of the inspectors for the purpose of granting certificates, Government ought (under Article 1 of the Convention) efficaciously

to supervise establishments engaged in the trade in living plants, make provision for the notification of disease, and take measures to prevent and combat diseases. A Government which interprets this as an encouragement to any extensive system of official control of the hygiene of nurseries will get little support from experienced plant pathologists. It is generally impossible to standardise remedial measures against any particular disease. The soil, climate, water conditions, and other external circumstances of any locality frequently have a most important bearing on the remedial measures to be applied and the way to apply them. Also the varieties grown and the period of the year when the attack develops, differ from place to place. Even in such a well-established treatment as seed disinfection against wheat bunt, there have been cases of failure due to local conditions and varieties grown, in India, Canada and the United States, and the same is likely to be true for certain diseases of nursery stock also. What Government can do is to provide information of the best available kind; its application to local circumstances requires local knowledge; and I would be sorry to enter into competition with an experienced and *well-informed* nurseryman in trying to check a disease in a locality of which I did not know the conditions.

Thus for the first time an attempt has been made to secure general recognition of the fact that the spread of plant diseases is largely due to human agency. To check this, the Convention goes as far as was perhaps to be expected in a first step. At the same time it is obvious that it does not go far enough to provide complete security, and in one or two respects it does not seem to take sufficient account of the facts regarding the dissemination of parasitic fungi, discussed above.

The Convention wholly fails to make any distinction between continuous and discontinuous dissemination of parasites. It has been shown that diseases that can make use of the methods of continuous dissemination to cross our frontiers cannot ordinarily be kept out, and there is little advantage in listing them. Fortunately India is not exposed to any appreciable danger from this class of disease. We have already, no doubt, received most diseases of neighbouring countries that could reach us in this manner; they are probably very few in number owing to our geographically isolated position; and except in the case of diseases newly introduced into Ceylon, which might spread to South India, or into the Malay Peninsula, which might reach Burma, it is hard to imagine our getting infected from outside in any other way than by means of conveyance on imported plants. To prevent danger from Ceylon and the Malay Peninsula is not easy, especially in such newly introduced crops as

rubber, and we can only hope that new diseases will be kept from entering these areas as far as possible, or that, if they do enter, the natural barriers to their spread will prove sufficient to protect India against them.

It follows from this that India should be prepared to list parasites at the reasonable request of Ceylon or the Federated Malay States, even though their host plants are not of importance to India. We might be asked to list a cacao disease, though the plant is but little grown in India, because it is a valuable crop in Ceylon. In such cases it might save trouble to stop cacao imports altogether, since they are probably quite unimportant. We should, of course, list any rubber disease that these colonies wanted to keep out, and would expect them to reciprocate by listing any diseases we did not want to get.

The proviso that only such diseases may be listed as are destructive or at least very harmful, leaves out of account the known facts of variation in virulence already referred to. Under it, it is probable that the chestnut bark disease could not have been listed, since it is said to do relatively little damage in China and Japan, whence it came. In preparing lists it will be wise to include all such diseases as there is reason to fear, from experience with allied parasites, may develop accentuated virulence if transferred to a new area, even though they are not very harmful in their original home. For the present, special regulations to deal with such diseases outside the Convention would have to be made, but it is to be hoped that they will ultimately be allowed to come under its scope. When a new crop, such as rubber, is introduced, there should be no hesitation in attempting to keep out every disease that it suffers from in its native home, which has dangerous potentialities, even though they may not actually be known to cause appreciable injury.

It has already been mentioned that certain diseases can be introduced on seed. Seed is frequently conveyed by post and there is no machinery for restrictive measures which could prevent dangerous importations by this road; seeds are expressly excluded from the Convention. In the United States Quarantine Act of 1912, nursery stock which is subject to restrictive legislation is defined to include seeds of fruit and ornamental trees or shrubs, but field, vegetable and flower seeds are exempted from the regulations, though it is provided that the latter may be extended to include exempted articles by the Secretary of Agriculture in case of need. Also the United States Post Office Order of July 1st, 1913, renders nursery stock unmailable in the International Parcels Post, unless addressed to the United States Department of Agriculture. Hence the United States has gone further than the Rome

Convention was prepared to go, but still allows the uncontrolled importation of most seeds, bulbs, and roots. This and the suggestion that a particular disease must be new and dangerous to justify inclusion in the schedules, are the chief weaknesses of the United States regulations, which otherwise seem to be well adapted for the purpose in view. Still the Secretary of Agriculture has power to extend these regulations to meet specific dangers, and has exercised them in the subsequent restrictive orders against warty disease of potatoes (tubers not having been included in the original definition of nursery stock), and against corn (maize) from India and Java, which might convey *Sclerospora Maydis*.

Botanic gardens and agricultural experiment stations are as liable to introduce exotic diseases as nurseries or any other agency which imports plants. A disease so introduced is not likely to be rapidly disseminated by infected plants being distributed throughout the country, as may happen where a nursery is concerned. Also there is somewhat less danger of diseases of valuable economic plants, widely grown in the country, being introduced, at least into Botanic gardens. Nevertheless there is considerable risk in giving differential treatment to such institutions on any considerable scale : and in the United States, for instance, only the Department of Agriculture may import nursery stock independent of restrictions except such as are prescribed by the Secretary of Agriculture, other institutions desiring to import plants for scientific or experimental purposes being subject to the same regulations as private firms.

It is clear that the Convention does not cover all classes of plants that might bring in disease. In particular it excludes produce of field cultivation (*produits de grande culture*). Potatoes, sugarcane, tobacco, many planters' crops, and our ordinary field crops are not protected. Hardly any of the diseases scheduled under the existing Destructive Insects and Pests Act in India come within its scope. This was perhaps inevitable, as only a very limited start could have hoped to secure unanimous support at the Conference. As it stands, the Convention is far from satisfying the requirements of most tropical countries and colonies, where horticulture is only a very small part of the agricultural industry. The majority of the dangerous diseases of foreign origin that should be prevented from entering India cannot find a place on its official lists. Still there is no reason why any country should not insist on certificates with imports of other plants besides those covered by the Convention. Once the machinery is in working order there will be no very great difficulty in obtaining these certificates from countries with adequate

Phytopathological Services. The newly organised French service appears to be prepared to give certificates for such produce as tubers, roots, and seeds of field crops, though these are outside the Convention. If this example is followed we may expect to be able to get certificates with most of our imports; under the present Indian Act we require them for potatoes from certain countries, for sugarcane and for rubber; and now that Europe is practically committed to the certificate system and the official agency for the purpose has been defined, it should not be long before certificates can be obtained, if needed, for most of our imported produce.

It remains to examine the restrictive clauses of the Convention, to see whether they go further than is justified in the interests of the country. They are chiefly contained in Articles 1 and 5, and deal with the supervision of nurseries, the control of transport and packing, the notification of diseases, the measures to be taken to prevent and check disease, and the granting of certificates after inspection. In all but the last a certain amount of latitude in interpretation is, I think, essential.

In considering how far the official supervision of nurseries and other establishments engaged in trade in living plants should go, a good principle to follow is that adopted at the Rome meeting, namely, that the object should be to facilitate trade while checking the dissemination of disease. A nursery engaged in the export trade must be kept as free from disease as possible, so that it may fulfil the requirements of the Convention, or of other regulations requiring certificates. To do this it must clearly not lay itself open to infection by continuing to purchase stock from other non-inspected nurseries. It would be best to cease to buy from such nurseries altogether; failing this, the only other course is to arrange for a very early inspection of the newly purchased stock and meanwhile to keep it as isolated from the rest of the stock intended for export as possible. It will be readily seen that the latter is not free from risk, as spores from newly introduced infected plants may easily reach other parts of the nursery through the air or otherwise. For nurseries engaged in internal trade only, the same restrictions are not so necessary. I have several times referred to the generally excellent means which fungi have for continuous spread outside human control, when the distance to be covered is relatively short; and as the spread by nursery stock within the country is only one of several ways by which the fungus can reach plants within, say, the same Province, we cannot often hope to do much good by severe restrictions on internal trade. It is difficult to foresee all cases, but it is fairly certain that the gradual spread of the great majority of diseases of which accurate records

exist, from infected areas to neighbouring districts, is largely independent of nursery trade. Hence there is not the same inducement to keep nurseries only engaged in internal trade free from infection, as there is when dealing with nurseries which trade with countries which the parasites can only reach if carried with the host plant. Naturally it is (or ought to be) the interest of every nursery not to sell diseased stock in the country, but it need not be the same pre-occupation of Government to keep up the good name of a nursery engaged in internal trade, as with an exporting nursery where the trade must inevitably cease under the international regulations when the stock for export becomes infected. An exception should be made with new diseases on their first appearance. Any nursery found infected might well be quarantined in such a case, and as it is often not in any way the fault of the nursery that it becomes infected, the question of compensation would arise. But once the disease has got a footing in several different parts of the country or has extended widely in a particular district, it seems to me that the Government service should concern itself chiefly with keeping exporting nurseries free from infection.

The control of transport and packing is probably less important (or perhaps it would be better to say, its effect is less accurately known) in the case of fungus diseases than with insect pests. In a general way there is relatively little danger of a fungus parasite, in a reasonably well packed consignment, escaping during transport. When it is present in the neighbourhood during packing (not necessarily on the plants packed), there is probably a danger of the packings becoming contaminated. Unfortunately there is little information on this point., but it seems undoubtedly to be possible. When the consignment is unpacked, spores thus carried might sometimes get loose. Hence it would be a wise precaution to pack and unpack away from growing plants or their débris, and preferably in sheds or other enclosed spaces, and also to burn all used packings very carefully.

The notification of disease can very easily be overdone, and there ought to be less rather than more need for it as time goes on. This is because at present many States require certificates stating that a particular disease does not exist near the locality from which the plants have come, whereas for all plants subject to the Convention nothing of the kind can well be demanded by one adhering State from another. In the discussions during the meeting at which the Convention was signed, it seems to have been generally recognised that the certificates should be passports to free entry (provided naturally that they are not found to have been wrongly given), and it might be advisable

to make this clear by adding a statement to this effect in the body of the Convention. Further, compulsory notification of diseases is only of value with new diseases and for them only until the disease has reached a moderately wide distribution, unless it is proposed to adopt compulsory treatment. In the present backward state of the knowledge of the occurrence and distribution of diseases in many countries, notification may appear important, but it seems probable that this state of affairs will not last long and then notification can only serve three purposes. It may be required to enable certificates to be given for plants not under the Convention or going to non-adhering countries, where the importing country requires the certificate to state that a certain disease does not occur near the exporting nursery; it may be required in order to restrict circulation of diseased stock in the country under the limits discussed above; and it may be required if compulsory treatment is adopted.

The question of compulsory treatment has been already referred to in part. I am not greatly in sympathy with any regulations of the kind, except for new diseases, and for so long as there is a reasonable chance of preventing their spread—generally for a few years only. My experience has been that it is impossible to "administer" a disease out of existence, though sometimes possible to confine it to a restricted area for a time. There have been exceptional chances of testing this in India and some of the colonies, and they have not been sufficiently successful to make it a hopeful line of treatment. In general I think the "measures to check and prevent disease" which Governments ought to take under Article 1 of the Convention, should not be in the direction of compulsory treatment or any other "standardised" methods, so much as in seeing that the best information is at the service of those who require it, and in giving advice and frequent practical demonstrations of the best ways to deal with a particular disease.

From the above it will be seen that there is nothing in the Convention which insists on any rigorous control of nurseries, or which should not be capable of being applied effectively without interfering unduly with such establishments, if administered in a common-sense fashion. Some points require modification or elucidation, but none of these touch the central principle, that the certificates of the Convention should be the passports to free circulation of nursery stock, and none are of such a nature as to prevent the adhesion of India, except the obscure point regarding the exclusion of wild plants without certificates. It is highly probable that other countries will press for a new Convention after the war, but the modifications required are not likely to be

considerable and may be expected to remove some of the weaknesses indicated above. It is unfortunately true that a Convention, once signed, cannot be altered, but the same procedure will probably be followed as in the Berne Convention of 1879, dealing with *Phylloxera* of the vine. In this case the modifications indicated by experience were incorporated in a new Convention bearing the date 1881.

If, therefore, the Convention is regarded as being primarily concerned with the control of inter-state circulation of plants; if wild plants from neighbouring areas are excluded from its scope; if the clauses which require that the stock to be exported should be in a satisfactory sanitary condition and that the Government service should supervise nurseries and take steps to prevent or check diseases, are broadly interpreted; and if the Government service is a good one; then I think there are obvious advantages in adhering to it, while pressing for the modifications suggested above and any others that may become evident in the next year or two in the working of the system in those countries that have already ratified it and set up the necessary machinery. To keep India free from the diseases of economic plants of importance, the Convention is only a first step, but after a few years' experience and as soon as other countries have established the organisation required if they wish to adhere, there seems to be a good prospect of a much more efficient control of the dissemination of fungus diseases to distant countries, than has ever been thought possible in the past.

PUSA,
July 19*th*, 1916.

APPENDIX I.

Distribution and extension of some parasitic bacteria and fungi, chiefly those causing diseases of cultivated plants.

The records below contain the brief history of the spread of most of the important cryptogamic diseases of cultivated plants whose extension has attracted notice during the past 70 years, before which there is little information available. It has been impossible to verify all the references with the facilities at my disposal, and in any case it must be understood that the published record of the appearance of a disease often does not occur for a year or more after the parasite has actually been introduced, even in the more advanced countries, while for much of Asia and Africa the date of record gives no indication of when the parasite was introduced. A thorough search through herbarium specimens would doubtless result in putting back the date of the appearance of several of the diseases referred to in different countries, but even then we would not always have an exact date for the introduction of the parasite. Hence the records must be taken usually as giving an approximate picture of the spread of a disease and are open to correction on further enquiry.

Disease	Host plants	Probable country of origin	Distribution and extension	How spread	Remarks
(1) Pear blight (*Micrococcus amylovorus*, Burr.)	Pear, Apple, Quince, Hawthorn and some other wild allied plants.	Probably eastern United States where it has been present for many years, probably over a century.	First attributed to bacteria in 1877-78 (Burrill), by which date it was prevalent in many parts of the United States, east of the Mississippi. Later reached the far west and south-west. Not known in Europe or Asia, except for a recent record (by Ferraris) in Italy (quoted by Shear in 1913). Has attracted little notice in Italy so far, possibly because of recent introduction or possibly has been incorrectly identified.	Chiefly by insects, some of which carry infected sap to the stigma, others (as *Scolytus rugulosus*) inoculate through wounds in the stem, others (Aphids) by punctures caused when sucking. One of the worst is *Lygus pratensis*. Also carried on pruning tools. Probably does not spread through air, as the bacterial masses are sticky. Was once thought to live in garden soil and to be blown with dust, but this is not now believed. Can be conveyed by cuttings or stocks for long distances.	
(2) Black rot of Cruciferæ (*Bacterium campestre*, Erw. Sm.).	Cabbage, Cauliflower, Turnip, Radish, etc.	Possibly Old World.	Probably first reported in Kentucky in 1889. Studied in Iowa by Pammel in 1893. All over eastern United States and west at least to Colorado. It is said to be not unlikely that it reached the United States from the Old World, and has spread greatly during the past 20 years.	Usually enters through the water pores on the leaf. Not believed to be commonly due to aerial borne germs, though is probably carried in dust at times. Often spread by leaf-eating and other insects. Perhaps can also infect from the soil, through wounds below ground.	

			Canada. Possibly Cuba and Porto Rico. All over north and central Europe; Russia; not seen in Italy. Demonstrated to be common in Europe in 1899-1900. Reported in England in 1903. Reported from New Zealand. Possibly in Japan. Formosa, 1914. India, 1914-15. Stated in 1916 to have been in South Africa since at least 1906.	Has been found on the seed of plants left for seed-bearing and shown to be able to survive for at least 13 months. Hence it can travel readily on seed, and it has been suggested that it reached the United States in this manner.	
(3)					
Crown gall (*Bacterium tumefaciens*, Erw. Sm.).	Peach, Apple, Raspberry, Blackberry, Grape, Rose, Hop, Radish, Tomato, Beet, Poplar, Willow, Chestnut, Paris daisy, etc.	[illegible] ?	References in United States from about 1892, but certainly present long before. Now widely distributed in United States where has been chiefly studied. References in Europe (chiefly on grape) from about 1885 but the European records are considered to be doubtful by United States authorities, except that in Italy (Cavara 1895-97). What seems to be the same disease is widely known in Germany, France (1885), Austria (1905 and earlier) and England, but the cause has not been determined in these countries. Reported from Peru in 1910. South Africa (1910, but said to be long present). Said to occur in Chili.	Local spread occurs readily, as a single diseased tree in an orchard may suffice in a few years to infect most of the other trees. The attack is just below the surface of the ground and the soil may become infected. Possibly carried by dust. Has been widely distributed throughout the United States with nursery stock from infected nurseries, and this is the chief means of long-distance dissemination.	

Disease	Host plants	Probable country of origin	Distribution and extension	How spread	Remarks
(4) Bacterial blight of Beans (*Bacterium Phaseoli*, Erw. Sm.).	French beans ..	United States ..	Known in the United States since at least 1892: New England to Louisiana and Nebraska. Not yet recorded elsewhere, unless the disease known as *graisse*, described from near Paris in 1899, is the same.	Attacks the seed within the pod and could doubtless be distributed for long distances with the seed.	
(5) Citrus canker (*Pseudomonas Citri*, Hasse).	Citrus fruits (Orange, &c).	Japan ..	Introduced into the United States about 1912, when found in South Alabama and Florida. Has been widely distributed throughout the Gulf States. Found in Japan, China and the Philippines in 1915. Cause ascertained in 1915. Reported from South Africa in 1916 and traced it in early in nurseries of grape fruit trees from Florida in 1905-6.	Came from Japan on stocks of Satsuma orange, or *Citrus trifoliata*. Has been distributed on nursery stock in the United States, probably from centres in Texas.	Stated in 1916 to be "the most dangerous enemy to citrus as yet known." An attempt is being made in Florida on a huge scale to exterminate it by burning.
(6) Spongospora scab of Potatoes (*Spongospora subterranea*, John.)	Potato ..	Believed to be indigenous on the eastern slopes of the Andes, where it is found on native varieties near the upper limits of potato culture.	Said to have been long known in Europe and seems to have been mentioned by several authors between 1841 and 1846, especially by Wallroth in Germany in 1842. The true nature of the disease was established by Brunchorst in 1886, from Norwegian material. Common in Quito in 1892.	Carried in same way as warty disease (No. 7). Certain United States investigators believe it to have been recently introduced from Europe. An outbreak in Florida has been traced to the use of seed potatoes from Maine.	

			Is perhaps widely distributed in potato-growing countries, but in some (Denmark, Holland) was overlooked until specially searched for recently, and is probably not common. Reported from Sweden in 1908. First recorded in United States (Maine) in June 1913, and believed to be a new introduction, but may have been overlooked previously. Found in Canada in early spring of same year.	
(7)				
Warty disease of Potatoes (*Synchytrium endobioticum*, Perc. =*Chrysophlyctis endobiotica*, Schilb).	Potato ..	new ?	First recorded from upper Hungary in 1896. Reported to have occurred in England (near Birkenhead) in 1901; In Cheshire and Wales (Dolgelly) 1902; Lancashire 1903; Scotland 1907; Ireland (Co. Down) 1908; Germany (Westphalia, Rhine Provinces and Silesia (Breslau) 1908; Newfoundland, October, 1909. Sweden (near Stockholm) discovered in 1912 but found to have been present since 1910 or 1911 and was introduced by empty sacks from a seedsman who dealt in German potatoes. Russia 1911. Belgium reported in 1913.	Chiefly by means of tubers, in which it is hard to detect in mild attacks or early stage. Also in manure from animals fed on diseased potatoes. Also on boots, implements, etc., of workmen and by infected soil. Said to live several years in soil, and so will infect succeeding crops direct from the soil.

Disease	Host plants	Probable country of origin	Distribution and extension	How spread	Remarks
(8) Grass blight (*Cladochytrium graminis*, Büsg. = *Physoderma graminis* (Büsg.) Fisch.).	*Dactylis glomerata*, *Festuca* and other small-leaved grasses.	?	First described by Büsgen in 1887 in Germany, where it occurs from Hamburg to Baden and Triglitz. In England was first reported in 1908, and was found in several widely separated parts in the south in 1913. Introduced from the Continent.	With seed. Appeared in 1908 in England in every instance where portions of a consignment of Continental grass seed had been sown. Found in the seed coats in 5 per cent. of seed that had given a diseased crop.	
(9) Warty disease of Lucerne (*Urophlyctis Alfalfæ* (Lagerh.) Magn.).	Lucerne ..	?	First observed in Ecuador in 1892, or shortly before. Switzerland (near Basel) reported in 1902; Alsace (Colmar) collected in 1902; Italy recorded in 1905; England (near Herne Bay) 1905-06; Bavaria seen in 1907; United States first recorded in 1909 in California; in 1910 observed in Oregon and became serious disease in 1911; found in Utah more recently. India collected in Punjab in 1911; Holland 1913. Not yet recorded from south-west Asia, the home of the host plant.	The resting sporangia are set free in the soil from the rotting tissues and can survive for several years (allied species for 7 years). The means of spread will, therefore, be much the same as in warty disease of potato, except that the seed is not known to be directly infected as potato tubers are. Long-distance spread is probably by contaminated soil or plant débris mingled with the seed as dirt.	
(10) Potato blight (*Phytophthora infestans* (Mont.) de B.).	Potato, Tomato and some allied wild plants.	Andes ..	First attracted general notice in Europe in 1845, when a violent epidemic extended from Norway to Bordeaux and from Poland to the Atlantic. Perhaps the first trustworthy	Can only be spread for relatively short distances by the spores. Long-distance spread entirely due to mycelium in diseased tubers.	

			observation of it was at Liége (Belgium) in 1842 ; but there were notes of potato diseases, which may have been in part this, in France, Belgium, and Germany in 1840 and 1841 ; in Norway, Denmark, and the United States in 1841-42 ; in Canada and Italy in 1844. It was epidemic in Canada and the eastern United States in 1845. The Island of St. Helena was ravaged by a potato disease for several years prior to 1844, which was probably the same. No evidence that it was known before 1840.	Following on the introduction of steamers, the rise of the Guano trade, and the use of ice at sea, diseased tubers are believed to have successfully crossed the zone of high temperatures which isolate the Andes, without having the internal mycelium killed. It would be of interest to ascertain if St. Helena was visited by South American steamers about 1840.	
			Subsequently it was found attacking wild Solanums at Quito in the Andes, near the home of the potato, and it is generally accepted that the disease spread from this area, where it has probably existed from time immemorial. The fungus cannot stand a high temperature for long and remained isolated till quick transport came in.		
			Reached the hills of South India perhaps between 1870 and 1880. First introduced to North India about 1883 with English potatoes ; spread rapidly along Himalaya and reached Khasi Hills in 1885. First reported in plains of Bengal in 1902, but died out from heat. Appeared again		

Disease	Host plants	Probable country of origin	Distribution and extension	How spread	Remarks
Potato blight (*Phytophthora infestans* (Mont.) de B.)	Potato, Tomato and some allied wild plants.	Andes ..	in 1912 but none since. Reported in every State in Australia in 1909, the earlier record in New South Wales in 1846 being doubtful. Is now practically everywhere that the potato is grown, except certain hot and dry regions.		
(11) Lilac blight (*Phytophthora Syringæ* Kleb.).	Lilac ..	Old World ..	First recorded in Germany (Hamburg) in 1905. At Geisenheim on the Rhine in 1910. Reported in Holland (Schoevers) in 1913. Not yet known elsewhere, though an allied fungus was described as *Ovularia Syringæ* Berk. in England in 1881 (*Gard. Chron.* II, 16, 1881, p. 665; II, 20, 1883, p. 439; and II 26). This does not, however, seem to be identical.	Spores suited for rapid dissemination are rarely formed, the chief spores being resting oospores buried in the tissues. Could be conveyed in living plants or cuttings.	
(12) Vine mildew (*Plasmopara viticola* (B. & C.) Berl. & de Toni).	Grape vine ..	United States ..	The fungus is common but only moderately destructive on the wild American grape vines and is probably indigenous in the United States. It was first observed in Europe, in Hungary, in 1877. France, observed by Planchon, in 1878; extended to the Rhone	Is well supplied with spores for short distance spread. Has also resting oospores buried in the tissues. Reached Europe as a result of the importation of American vine stocks introduced to replace those destroyed by *Phylloxera*.	

			and Savoy districts in 1879. Italy (Pavia) 1879; Algeria and South Tirol 1880; Greece 1881; Alsace 1882; Recorded in Australia (McAlpine & Robinson) 1898; Recorded in Java (Breda de Haan) 1905, and believed to have been imported on fresh fruit on the mail boats. Reached Cape Colony in 1907 or shortly before, the previous record by Schroeter in Engler's "Pflanzenfamilien" being unsupported by evidence (Lindau, *Notizblatt K. Bot. Gart. Berlin*). Recorded in China 1913, Japan 1913 or earlier, Formosa and Uruguay 1914. Collected in India in 1910, but not known when introduced.	Has travelled to other areas chiefly with vine stocks but possibly at times with the fruit.
(13) Downy mildew of Cucurbits (*Pseudoperonospora cubensis* (B. & C.) Rost.).	Melon, Cucumber, Marrow, Gourds and allied plants.	?	First described from Cuba in 1868; collected in Japan in 1888; United States (New Jersey) 1889, and spread rapidly over eastern and southern States. England observed in 1899; collected in Brazil in 1900; Russia and Java 1902; Hungary, Italy, and East Africa 1903; Austria 1904; China 1908; India 1910 (newly introduced to Pusa); Australia 1910-11; Russian Manchuria 1914; Formosa 1914.	Is well supplied with spores for short-distance spread, but only these short-lived, "summer spores," are known with certainty, the record of resting spores (oospores) in Russia being very doubtful. If they occur they are certainly rare. The fungus is not known to reach the seed. The long-distance spread of this fungus presents one of the greatest mysteries of any known parasite and no explanation can yet be offered to account for it.

Disease	Host plants	Probable country of origin	Distribution and extension	How spread	Remarks
(14) Sedge mildew (*Kawakamia Cyperi* Miyabe).	*Cyperus tegetiformis.*	East Asia ..	First described in Japan in 1904. Recorded in Formosa 1914. Recently introduced into the United States (Texas) in an attempt to establish the grass mat industry of China and Japan.	Is well supplied with spores for short-distance spread. Was introduced into the United States by an emissary of the U. S. Department of Agriculture who obtained large quantities of the host plant from Japan. Travelled in the living plants.	
(15) Vine oidium (*Uncinula necator* (Schw.) Burr.).	Grape vine ..	United States ..	Long known in the United States where it is probably indigenous. Appeared first in Europe in a greenhouse at Margate (England) in 1845. Seen in one of Rothschild's greenhouses at Suresnes, near Paris 1847. On vines in gardens round Suresnes, and in Belgium 1848. All around Paris 1849. Bordeaux, Spain, and Italy 1850. All over France, Spain, and Italy; in Switzerland, Hungary, and along the shores of the Mediterranean (Greece, Syria, Asia Minor, and Algeria) 1851. In 1854 reduced French harvest to between 1/10 and 1/20 of the normal. Australia 1866-67. Is now found practically wherever the grape is cultivated. It may be taken to have reached every vineyard in Europe by 1851.	Has enormous numbers of "summer spores." In the United States has also a durable "winter stage" (perithecia) but this was not found in Europe until 1892 and is formed only rarely in Europe. Introduced either as persistent mycelium, patches of which have been shown to develop in autumn and to remain dormant on the twigs till the following season, when they bear summer spores; or perhaps may have come over as perithecia. In either case it travelled with living vine stocks imported from the United States. Its subsequent long-distance spread was probably in the same manner.	

(16)					
Euonymus oidium (*Oidium Euonymi-japonici* Sacc.).	*Euonymus japonicus.*	Japan ..	First recorded in 1900 in Livorno, Italy, but subsequently found had been collected at Florence in 1899. England (Sussex) 1903 but it is said to have been seen at Seaford on the coast in 1902. Austria (near east Italian frontier and in south Tirol), and at Padua in Italy 1903. Naples, and at Avignon, near Paris and elsewhere in France 1904. Now throughout southern and western Europe.	Only the summer stage of this fungus is known, but it is believed that it is the same as an endemic form of *Erysiphe Polygoni* D. C. which is known in Japan on the same host. It lives through the winter as persistent mycelium and doubtless travelled from Japan on living plants or cuttings in this manner.	
(17)					
American Gooseberry mildew (*Sphærotheca mors-uvæ* (Schw.) Berk.).	Gooseberry, Currant and some wild species of *Ribes*. Also said to attack Raspberries sometimes.	United States ..	Known in the United States since 1834 on wild species of Ribes, and probably indigenous. First reported in Europe from north Ireland in 1900. Reported in Russia in 1902, but was probably present from 1900 or even earlier, and the foremost Russian authority (Jaczewski) thinks may have been introduced to the southern districts from the U. S. as far back as 1890. Specimens were collected in Russia in 1901. Reported in Denmark in 1904, but there is evidence that it was present in 1900 and reached Sweden and Norway with plants bought from a nursery at Korsör (Denmark) in 1900,	Is abundantly provided with summer conidia. Was not spread over long distances in Europe by the wind as the records in many countries show. Has numerous "winter spores" (ascospores) formed in the mycelium on the bushes, within durable perithecia. Travels readily by means of these for long distances on living plants and (as they become dislodged fairly easily) probably also in packings. Eriksson, the well-known Swedish mycologist, thinks it was chiefly distributed from Russia and Denmark,	In the United States, *Ribes aureum*, currant and raspberries are either immune or only attacked under exceptional circumstances. For this and other reasons some believe the parasite has developed accentuated virulence in Europe. American gooseberries (chiefly *Ribes oxyacanthoides* and *R. cynosbati*) are not much injured but *R. Grossularia* cannot be grown successfully though its hybrids

Disease	Host plants	Probable country of rigin	Distribution and extension	How spread	Remarks
(17) American Gooseberry mildew (*Sphærotheca mors-uvæ* (Schw.) Berk.).—*Contd.*	Gooseberry, Currant and some wild species of *Ribes*. Also said to attack Raspberries sometimes.	United States ..	the disease being observed in Sweden in 1901, though not reported until 1905. It is believed to have reached Denmark direct from the U. S. Finland 1904 (imported from Russia). Germany 1905 (Posen, probably from Russia) but it is said to have reached Sweden on German plants in 1904. Austria 1905 or 1906, and spread to many places from one nursery. England 1906 on wild *Ribes aureum* stocks from France and shortly after on gooseberries near Eversham, where for several years previously plants had been imported from the Continent. Hungary 1908. Belgium 1909 or 1910. Reported in France for first time 1913 but must have been present since 1906 if the record under England is correct. Recorded from Russian Manchuria 1914 but has been prevalent since 1912. Not known in Japan up to last year (verbal communication from Yamada at Kew, 1915). By 1915, no European country that grows gooseberries was free.	there being no evidence of its distribution from Ireland. There is no evidence that it over-winters in the mycelial condition or could travel long distances in this form.	with the other two can.

(18) Oak mildew (*Microsphæria Alni* (Wallr.) Salm. a specialised form).	Oak and other species of *Quercus*.	United States ..	Common on species of *Quercus* in the United States, where it is probably indigenous as an endemic form of this common mildew. First noticed in Europe in the west and centre of France in 1907. Spread with phenomenal rapidity and in 1908 was known to be in most countries except Russia, Roumania and perhaps the rest of the Balkans and Scandinavia. In 1908 (end) also in Algeria. In 1909 reached Riga and the Caucasus in Russia, and also Turkey, Asia Minor, and Madeira.	Produces great numbers of summer spores and its rapid spread throughout Europe suggests aerial dissemination through comparatively long distances. In this it differs from most of the other diseases recorded. Winter fruit (perithecia) first found in France in 1911, but seem to be produced only under exceptional circumstances. Usually passes the winter in the mycelial condition more or less dormant until spring when new summer conidia are formed. Ornamental species of *Quercus* are said to be sometimes imported to Europe from the United States and no doubt the fungus travelled on these in the dormant condition. Perithecia may also have come on such plants.	The virulence is said to be declining in places, as in France in 1912 and in Croatia in 1910-11, though, there was a recrudescence in the latter area in 1912, associated with an epidemic of a leaf wasp.
(19) Mildew of Rue (a specialised form of *Oidiopsis taurica* (Lèv.) Salm. described under the name of *Ovulariopsis Haplophylli* (Magn.) Trav.).	Rue and *Haplophyllum*.	South-West Asia..	Collected in Palestine by Bornmüller in 1897 on *Haplophyllum* sp. (a section, according to many, of *Ruta*). Found in Italy on *Ruta graveolens* (rue) in 1913. Does not seem to be known elsewhere.	Has the usual summer spores and winter fruit of the mildews but there is no evidence to show how it reached Italy, or even if it is a new introduction or had merely been overlooked.	..

Disease	Host plants	Probable country of origin	Distribution and extension	How spread	Remarks
(20) Black rot of the Vine (*Læstadia* (*Guignardia*) *Bidwelli* (Ellis) Viala and Rav.).	Grape vine ..	United States ..	First signalled in the United States in 1848, but was certainly present long before.	Is abundantly supplied with summer spores and winter fruit.	Though the fungus does much damage at times in the United States there are certain American species as *Vitis rotundifolia*, which are highly resistant to its attacks.
			Found first in Europe in France (Hérault) in 1885. Did much damage in le Lot, l'Aveyron, and le Lot-et-Garonne, 1887. A few years later was all over south-east and south-west France. Its present distribution in Europe is difficult to ascertain. It had not been found outside France up to 1907. It was not in Italy at least up to 1913 (the former record having been found to be due to confusion with another parasite). In Spain, it was first recorded in 1914 in the region of Valencia. Algeria seems to be free at present.	Is said to have been introduced into France on American vine stocks. It is very closely dependent on special weather conditions to cause epidemic outbreaks.	
			There was an outbreak reported in the Caucasus in 1896, but subsequent investigations showed this to be due to an allied species. First recorded in South Africa in 1911.		
(21) Tomato, Melon, and Cucumber spot or canker (*Mycosphærella citrullina* Gros.).	Melon, Cucumber, Tomato.	United States ..	Was probably observed in the United States (Delaware) in 1890 but the cause was not accurately determined. First fully studied in New	Is abundantly provided with Summer spores and has also winter fruit (perithecia). It is not clear how it reached England, if it	

			York State in 1907-08. First record in Europe in England in 1909, as quite recently received at Kew on tomatoes from Waltham Cross and on cucumbers from Gloucestershire. On tomatoes from Guernsey and Kenilworth, 1910.	came from the United States, as it is said that living melon plants (on which it chiefly occurs in the United States) are not imported to England from America. It might however, travel with seed to which spores have gained access.	
(22) Chestnut bark disease (*Endothia parasitica* (Murr.) And.).	Chestnuts (*Castanea dentata; C. vulgaris, C. pumila, C. crena'a*) ; also Oaks (rarely).	East Asia ..	First seen in Bronx Park, New York, in summer 1904, but said was certainly at that date scattered in 3 or 4 of the neighbouring counties. In a few years had exterminated the chestnuts in New York and Brooklyn. Eight States infected in 1908. New Hampshire to Virginia and west to the borders of New York State and western Pennsylvania, but not yet in Ohio or Indiana in 1914. Found on two single trees imported from Pennsylvania in two localities in Nebraska towards end of 1914. In 1908, loss estimated at 5 to 10 million dollars in and around New York city. In 1911, 25 million dollars was considered a conservative estimate. In 1912, the total loss to date was said to be about 50 millions. Up to 1912, no case reported of a tree or grove once attacked having been saved by any method.	The summer spores (pycnospores), formed in enormous quantities, are extruded with mucilage and remain adherent till well wetted. They spread the disease on the tree but are not well suited for wind dissemination. Great numbers of ascospores are also produced, and as they are shot out into the air, they are suitable for wind dissemination. Birds and insects might carry the pycnospores, which have been found in quantity on woodpeckers. The most dangerous means of extensive (discontinuous) spread was found to be on living plants from nurseries. Pycnospores separated out in water and then dried on glass slides may live up to two weeks; ascospores up to 35 days. If not dried first from water live longer, and this	Some American workers early suggested that the disease was of Asiatic origin, on the ground of the relative immunity of Japanese, Chinese, and Korean varieties. This opinion was triumphantly vindicated in 1913.

Disease	Host plants	Probable country of origin	Distribution and extension	How spread	Remarks.
(22)					
Chestnut bark disease (*Endothia parasitica* (Murr.) And.).—*contd.*	Chestnuts (*Castanea dentata*; *C. vulgaris*, *C. pumila*, *C. crenata*); also Oaks (rarely).	East Asia	Early noticed that the Japanese chestnut (*C. crenata*) was more resistant. Japanese, Chinese, and Korean varieties had been introduced for growth in the United States, especially Japanese. Hence a search was made for the disease in East Asia and it was discovered in Northern China by an emissary of the United States Department of Agriculture (Meyer, reported by Fairchild) in 1913. The parasite was proved by cultures in the United States to be identical. Quite recently (1915) it has been found on wild and cultivated trees in Japan.	is also the case with spores liberated on the bark or leaves. A strip of mountain, 30 to 40 miles broad, free from chestnuts, west of the heavily infected Hudson valley, kept the disease from spreading across it for at least 10 years.	
(23)					
Black knot of Plum, &c. (*Plowrightia morbosa* (Schw.), Sacc.).	Plum, Cherry and some wild American species of *Prunus*.	United States	Described in 1821 in the United States where has probably been for very long, as there is a record of an epidemic in cherries in Pennsylvania in 1790. It is probably indigenous on wild species of *Prunus*. Occurs throughout the eastern States from New England to Alabama, and west beyond the Mississippi. Not yet known in Europe.	Spore production very copious, both summer and winter forms being produced. Well suited for wind dissemination. It is said that the import of living plants subject to this disease is not likely to have occurred from the United States, as they (especially the plums) are inferior to the European varieties.	

(24) Bamboo smut (*Ustilago Shiraiana* Henn.).	Bamboos ..	Japan ..	Imported from Nagasaki, Japan, to the Chico Experiment Station, California, in 1909, and detected on the imported plants in 1910.	Came with the living plants.	
(25) Coffee leaf disease (rust) (*Hemileia vastatrix* B. & Br.).	Coffee and the wild and semi-wild African species of *Coffea*.	Probably eastern or central Africa.	First seen in Ceylon in 1868; Mysore 1869; Sumatra and Java 1876; Natal probably 1878; Fiji Islands 1879; Mauritius about 1880; Réunion 1882; Philippine Islands 1885; Madagascar since at least 1886 but is said to have been first introduced in 1872 or 1873 by a Ceylon planter who came to examine coffee growing in the island. Tonkin 1888; reported in Malaya and Borneo 1888; Samoa 1894 (said to have come direct from Ceylon); New Hebrides about 1909; New Caledonia 1911. Is widespread in Africa near the great lakes and has been found as far west as long. 23° E. in the Congo. In this area grows on wild or semi-wild species of *Coffea* and is probably indigenous.	Uredospores produced in vast numbers and can survive for some weeks, having been germinated in Germany after coming from Mauritius *viâ* England. Durable spores (teleutospores) rare and have only been seen by one observer (in Ceylon). Would travel readily for comparatively long distances as living uredospores which had reached the seed or packings. Was probably introduced into the Fiji Islands with a box of Ceylon seed packed in soil. Could also be carried readily on living plants and it is on record that such living plants of the newer African varieties have been sent to Java and possibly elsewhere from Brussels. Whether living plants were moved long distances as far back as 1860—70 is doubtful.	Many of the more recently introduced African species of *Coffea* are relatively immune, which supports the idea that the disease is of African origin.
(26) Rusts of orchids (*Hemileia americana* Mass.) *H. Phaji* Rac., *H. Oncidii* Grif. & Maubl., and probably other allied forms.	*Cattleya, Phajus, Oncidium,* and probably also *Epidendrum* and *Lycaste.*	Tropics ..	*H. americana* was imported to England from Costa Rica on leaves of *Cattleya Dowiana* in 1899. The spot was single when received, but falling spores infected other leaves. The rust was previously un-	Have reached Europe with their host plants. Can spread, if conditions of temperature, humidity, &c., remain favourable, by means of spores, from plant to plant.	

Disease	Host plants	Probable country of origin	Distribution and extension	How spread	Remarks
(26) Rusts of orchids (*Hemileia americana* Mass.) *H. Phaji* Rac., *H. Oncidii* Grif. & Maubl., and probably other allied forms.—*contd.*	*Cattleya, Phajus, Oncidium,* and probably also *Epidendrum* and *Lycaste.*	Tropics ..	known. *H. Phaji* was found on *Phajus Wallichii* in the Botanic Garden, Dublin, in 1911, and there is a specimen in the Kew Herbarium probably from some British source. The fungus was first described in Java in 1900. *H. Oncidii* was imported by Messrs. Stuart Low & Co., from San Paulo, Brazil, in 1909, on *Oncidium varicosum.* and probably the same fungus was seen in the Botanic Garden, Dublin, on this host and also *O. Forbesii.* It has also been imported into France, where it was first described. Other similar rusts seem to have been observed on *Epidendrum vitellinum* and *Lycaste Skinneri.*	Grove ("British Rust Fungi," 1913) remarks that these tropical fungi "might easily become dangerous parasites in Orchid houses, if allowed to spread." Each is, however, probably confined to a single genus, if not species, of host plant, and so far there seems to be no record of much damage.	
(27) Carnation rust (*Uromyces caryophyllinus* (Schrank) Schrœt).	Carnation, Dianthus, Gypsophila.	Europe ..	Known in Europe, since 1789. First reported in the United States (Michigan) in 1890. Spread rapidly and was exceedingly virulent for the first few years, but by 1896, was reported to be doing less harm.	As with most other rusts, local spread during the growing season is secured by the uredospores which are relatively short-lived but have been shown in many cases to survive for several weeks, or even, sometimes, for some	

			Does relatively little damage in Europe. Has reached Australia and other parts of the world.	months. A second spore form, the teleutospore, is more resistant and in many species carries the fungus over to the following year. Long-distance spread has probably occurred on living plants or cuttings.
(28)				
Euphorbia rust (*Uromyces Euphorbiæ* Cke. & Peck).	Euphorbia ..	America ..	A case has been recorded where this rust was introduced into upper Italy on *Euphorbia Presslii* from America. It is mentioned merely as a recorded example of the introduction of a parasite which does not cause an important disease of a plant of economic value, but which accompanied its host plant. There are a good many similar cases on record, and probably most large herbaria could show one or more examples of exotic parasites thus introduced. The two grass rusts on *Elymus* and *Beckmannia* imported to Australia from the United States have already been mentioned (p. 29). Yet, because such plants of little or no economic value are rarely imported, the proportionate number of their parasites that have become widely distributed is much less than in the case of cultivated plants. For instance, Massee has	It has been demonstrated by Carleton that this rust can be carried on the seed: plants from such seed became rusted unless the seed was disinfected before sowing (*Euphorbia dentata*).

Disease	Host plants	Probable country of origin	Distribution and extension	How spread	Remarks
(28) Euphorbia rust (*Uromyces Euphorbiæ* Cke. & Peck.)—*contd.*	Euphorbia ..	America ..	recently stated (*Jour. Econ. Biology*, X, June 1915, p. 47) that there are no less than 30 species of *Puccinia* on wild plants in Scandinavia, Belgium, France and other neighbouring countries, not yet recorded in Britain, though their host plants grow wild in this country; while about an equal number of British species are absent from these countries, though their host plants are found there.		
(29) Hollyhock rust (*Puccinia malvacearum* Mont.).	Hollyhocks and many other *Malvaceæ*.	Chili ..	First collected on marsh mallow (*Althæa officinalis*) in Chili by Bertero prior to 1831, and described by Montagne in 1852. Observed in Australia (near Melbourne) in 1857; collected in Australia in 1865; collected in Spain for first time in Europe in 1869. In several parts of France, various places in England, and Rastadt in Baden in 1873. All over Holland, Stuttgart, Erlangen, Nurenberg and Lubeck (Germany); on Fünen (Denmark); near Rome and Naples (Italy) in 1874; Erfurt (Germany), Switzerland, Cape of Good Hope 1875. In New Zealand since at least	Has only the teleutospore stage. The spores can germinate as soon as formed and give small short-lived "sporidia," which infect new plants and are disseminated by the wind. The teleutospores themselves do not fall off readily but remain mostly *in situ* till the plant withers and disintegrates. They are therefore carried on living infected plants or cuttings. According to Taubenhaus (*Phytopathology*, I, p. 58) the fungus overwinters in three ways; (1) As	Massee remarks (*Kew Bulletin*, 1913, p. 345) "when the hollyhock disease first appeared in Europe it rendered the cultivation of that plant well-nigh impossible. To-day hollyhocks are again in cultivation, and although the rust is present it does no material harm."

			1875. Münster, Bremen, Greifswald (Germany); Linz and in Krain (Austria); Hungary; Lombardy 1876; Brandenburg, on the Rhine, on the Elbe (Germany); near Athens 1877. First recorded in the United States (Massachusetts) 1886, introduced on seeds of imported Malope. Near Stockholm 1887. In 1889 was spreading in the United States, found in a nursery and in the Experiment Station at Geneva (New York), later in New Jersey and North Carolina. Finland 1890. Is known in Siberia: probably Venezuela (as *P. Sidæ* Pat. 1888). Not yet seen in India.	developing mycelium in the tender young leaves, leaves infected in late autumn giving ripe teleutospores in early April; (2) As mature, hibernating teleutospores in living or dead parts of the plant; these spores are formed in late autumn and remain on the plant; (3) With the seed. The actual seeds are usually free from the fungus, but the enclosing bracts and sometimes also the persistent carpels bear spores. Infected fruits and carpels of *Malva rotundifolia* collected in November and planted with the seed in April caused the infection of the young plants and the formation of ripe teleutospores. Blaringhem in France holds that the seed carries the fungus in the obscure form known as "mycoplasm." It was undoubtedly spread by the trade in living plants and seeds.
(30) Sunflower rust (*Puccinia Helianthi* Alb. & Sch.)	Sunflower and other species of *Helianthus*.	America ..	First recorded in Carolina, United States, in 1822. Appeared in epidemic form in the sunflower cultivation of south Russia from 1866 to 1869. Spread westward from Russia, reaching Hungary soon after 1869, then Austria, and was	All the known spore forms of the rusts are found on the host plant, though the æcidial stage does not seem to have been found except in America and Russia. The teleutospores may germinate as

Disease	Host plants	Probable country of origin	Distribution and extension	How spread	Remarks
(30) Sunflower rust (*Puccinia Helianthi* Alb. & Sch.)—*contd.*	Sunflower and other species of *Helianthus*.	America ..	found in Silesia in 1874 and in Italy about the same time. In 1875, had not yet been recorded from Germany outside Silesia, from France or from England. Sydow's Monograph of the Uredineæ (1902) states that it occurs throughout most of Europe but does not give France or Britain. It is not mentioned in Grove's "British Rust Fungi" (1913). Recorded in Australia from 1887; China 1912. Known in Japan in 1913.	soon as ripe or may remain over the winter and germinate in the following spring. Spores would be likely to get on the seed and could be conveyed in this manner for long distances.	
(31) Chrysanthemum rusts (*Puccinia Chrysanthemi* Roze.).	*Chrysthemum indicum* and *C. chinense*.	Japan ..	Probably indigenous to Japan, where it is very common. First European record in England in 1895 (though the chrysanthemum was introduced more than a century ago). France 1897; Italy, Denmark and Germany 1897 or 1898; Switzerland 1900. Reported in the United States (Massachusetts) in 1897; and in Indiana in 1899. Reached Australia (New South Wales) in 1904. New Zealand 1904. Collected in India (Nilgiris) 190 '	In the warmer coast region of Japan it is found only in the uredo stage, but in the colder parts in the interior the teleutospores are regularly produced. In Europe the teleutospores are rarely found but have been seen in France when first introduced. In Australia and India only the uredo was found. The uredo stage persists on the young shoots which come up at the end of autumn, and can remain on these shoots through the winter even in the open air.	

				Long-distance spread is on living plants or cuttings. It is believed to have reached Germany on new English varieties, and was imported into Australia on cuttings from England.	
(32) Asparagus rust (*Puccinia Asparagi* DC.).	Asparagus ..	Europe ..	Has been known in Europe for over a century, and is widely distributed. First observed in the United States in 1896, when spread rapidly in New Jersey and was found on Long Island, New York State. By 1901 had reached the Pacific coast, causing everywhere serious injury. In 1906, was said to be in every State in which asparagus was grown. It has been collected in Abyssinia. Not known in Australia (up to 1905) nor India.	All the spore forms occur on the host plant. The teleutospores which are formed in the autumn remain on the plant or fall to the ground, where they remain till the following spring and can infect the new crop. It is stated to have been introduced into the United States, no doubt on its host plant, from Europe.	It proved more destructive in the United States than in Europe, and English varieties that resist the disease have been introduced into America and their hybrids with local varieties were recently stated (1914) to be giving good results.
(33) Maize rust (*Puccinia Maydis* Béreng.).	Maize and Teosinte (*Euchlæna mexicana*)	America ..	Is not mentioned in European records up to 1815 (Frank) or 1837 (Schroeter). Herbarium records of Desmazières (? France) and from Holland in 1827; Italy 1815 or 1844 (when first named); Austria 1861; Baden (near Rastadt) about 1875. Is now practically wherever maize is grown. Is believed to be indigenous to the United States or Central America and was included with the sorghum rust under the name of *P. Sorghi* by Schweinitz ("N. Amer. Fungi") in 1831.	Like the other cereal rusts this fungus probably travels on or with the grain, or in straw packing, for long distances. It has an alternate stage on species of *Oxalis* in America, Europe, and South Africa, but can evidently dispense with this stage.	

Disease	Host plants	Probable country of origin	Distribution and extension	How spread	Remarks
(34) Vine rust (*Phakopsora Vitis* (Thuem.) Syd.).	Grape vine, also *Vitis inconstans*, *V. flexuosa*, *V. lanata*.	? United States ..	First collected by Ravenel in the United States (Thuemen, "Pilze des Weinstockes," 1878, p. 182). Jamaica 1890 (Lager- heim); also known in Trinidad and St. Vincent. Java 1899. Japan 1899. Formosa 1914. Said to have caused the entire loss of the crop on affected plants in Jamaica. Not known in Europe. An allied species (*Phakopsora cronar-tiiformis* (Barc.) Diet.) occurs in great profusion on *Vitis himalayana* in the Himalaya, where the leaves are often smothered in spores. It is not yet known elsewhere.	Is known chiefly in the uredo stage (*Uredo Vitis* Thuem., *U. Vialæ* Lagerh.). The teleuto stage was first described from Japan in 1899. The life history of this genus of the rusts is quite unknown, the teleutospores not having as yet been germinated. Said to have been introduced into the West Indies from the United States. Would doubtless travel readily on living plants.	
(35) Rust of *Peltandra* (*Aecidium importatum* Henn.).	*Peltandra virginica*.	United States ...	This fungus developed on the stems and midribs of the host on plants grown from rhizomes imported to Germany from North America in 1894. It was not previously known, but presumably occurs in the United States. This seems to be a similar case to No. 28 above.	Is believed to have been carried in the rhizomes of the host plant.	

(36) Blister rust of white Pines (*Peridermium Strobi* Kleb. = *Cronartium ribicolum* Dietr.).	Five-leaved Pines, *viz.*, Stone Pine (*P. Cembra*), Weymouth Pine (*P. Strobus*), Sugar Pine (*P. lambertiana*) also *P. monticola* and possibly *P. excelsa*. The perfect (*Cronartium*) stage is known on Currant, Gooseberry and over 20 other species of *Ribes*.	Old World (possibly interior of Russia).	The fungus was first described from the southern shores of the Baltic in 1859 (collected about 1855). It caused an epidemic in Finland between 1869 and 1875. It was found in north Germany in 1872; Denmark 1872; Holland 1882; Sweden 1888; France 1890; Austria 1890; England 1892 (but the *Peridermium* stage had been seen some time before). Belgium 1894; Norway 1896; Switzerland 1898. Most of these records were on the Weymouth pine, which had been introduced to Europe from America (its native home) about 200 years ago. That the fungus had an alternate stage on curran's and other species of *Ribes* was first established in 1888. Neither of the two forms of the fungus seem to have been seen in the United States until 1892, when the uredinal form was found on *Ribes longiflorum* in Kansas. This stage was again found at Geneva (New York) in 1906, and has since appeared in several localities (chiefly on currants). The *Peridermium* stage has been frequently introduced into the United States since 1903, several million diseased seedling pines having been sent chiefly from Hamburg. Over 230 localities have been found	Local spread takes place by means of the æcidiospores (*Peridermium* stage) from pine to *Ribes* only, not from pine to pine. In the same way the winter spores (*Cronartium* stage) can only spread from *Ribes* to pine, not from *Ribes* to *Rtbes*. There is, however, another spore form (uredo) on *Ribes* which can spread from *Ribes* to *Ribes*. For long-distance spread, the stage on *Ribes* can travel in dormant *Ribes* stocks or cuttings in the bud scales and young twigs. The *Peridermium* stage is conveyed in the interior of the stem in the mycelial condition, in which it could escape even expert inspection. After infection there is a long incubation period (from one to several years) before the first spores are produced, and during this period there may be no symptoms until a few months before spore formation, when the bark thickens at the infected part. On the other hand the incubation period on *Ribes*, after infection from the pine, is only about 12	Has rendered the growth of the Weymouth pine almost impossible in parts of Europe (Denmark, Holland) and often kills from 15 to 100 per cent. of young trees.

Disease	Host plant	Probable country of origin	Distribution and extension	How spread	Remarks
(36) Blister rust of white Pines (*Peridermium Strobi* Kleb=*Cronartium ribicolum* Dietr.)—*contd.*	Five-leaved Pines, *viz.*, Stone Pine (*P. Cembra*), Weymouth Pine (*P. Strobus*), Sugar Pine (*P. lambertiana*) also *P. monticola* and possibly *P. excelsa*. The perfect (*Cronartium*) stage is known on Currant, Gooseberry and over 20 other species of *Ribes*.	Old World (possibly interior of Russia).	growing diseased imported Weymouth pines and recently it has been found on large native pines in Vermont (1914). In all cases except the last, *Ribes* were fortunately absent, and as spread from pine to pine cannot occur but only through *Ribes*, the disease is not believed to have become widely established yet in the United States. It was found (introduced) in Ontario, Canada in 1909, and was well established in both its stages by 1914, over a considerable area. The present distribution is all Europe except the Balkans and Iberian Peninsula; Siberia, Japan, Sakhalin, and perhaps the Himalaya.	days, when uredospores are formed, the teleutospores appearing 1½ months or more after the uredospores. Though common in England in recent years, it was first observed in Ireland in 1915, apparently newly introduced on nursery stock.	† But see U.S. Farmers' Bul 742 1916 p. 15, where it is stated that 11 cases of spread to Ribes occurred between 1909 and 1914, & in 1915 12 new cases occurred.
(37) Blister rust of Scotch Pine (*Peridermium Fischeri=Coleosporium Sonchi-arvensis*).	*Pinus sylvestris*. The perfect stage (*Coleosporium*) occurs on *Sonchus arvensis* and other species of *Sonchus*.	Europe ..	Long known in Europe. Was introduced into the United States and first seen in 1912 in a single nursery in Wisconsin. The perfect stage (*Coleosporium Sonchi-arvensis*) was found in the neighbourhood on *Sonchus asper*, so it has probably become established. Not known elsewhere in United States up to 1914.	Much the same as the above, except that there is not such a long incubation period on the pine. The damage caused is also less.	

(38) Rusts of Chinese juniper (*Gymnosporangium Photiniæ* (P. Henn.) Kern = *G. japonicum* Syd.; and *G. koreæense* (P. Henn.) Jackson = *G. Haræanum* Syd.).	*Juniperus chinensis*. The alternate stages, *Ræstelia Photiniæ* and *R. koreæensis*, occur on *Photinia* (*Pourthiæa*) *villosa* and on *Pyrus sinensis*, *Cydonia vulgaris*, and *C. japonica*, respectively.	Japan ..	Collected first in America (Connecticut) in 1911 on stock of Chinese juniper just imported from Japan. It was subsequently found that both the fungi mentioned were mingled on the specimens. *Ræstelia koreæensis* was first found in the United States (California) in 1913 on *Pyrus sinensis*, in a nursery run by Japanese, and it is assumed that infected trees of *Juniperus chinensis* must have been previously imported in the neighbourhood. It was again found in Oregon in 1914 on the same host and the following year *Gymnosporangium Haræanum* was found on Chinese junipers near by. *Gymnosporangium Photiniæ* was found again at Seattle in May 1915, no doubt as a separate importation, since practically all the examples of chinese juniper are imported from Japan.	These rusts have reached the United States on the juniper, and subsequently spread to the Japanese pear in the case of *G. Haræanum*, which has thus become established in the United States.	As in all species of *Gymnosporangium*, the infection of the teleuto-bearing host (the juniper in these cases) occurs in the summer, and the spores do not appear in maturity until the following spring or even a year or more later. Several species are perennial. Hence it is easy for these fungi to escape detection and they could readily travel in the mycelial condition within the host.
(39) Blister Blight of Azalea (*Exobasidium* sp.).	*Azalea indica* ..	Probably Japan..	This fungus was first seen in Europe in Holland where it was recorded in 1906. Italy (near Rome) 1907; Germany, England (Cornwall) 1908. Reported in Belgium (near Ghent) in 1913. The identity of the parasite is still doubtful but it is believed in Germany to be either *Exobasidium japonicum* or *E. pentasporium*, which occur in this plant in	The spores are probably, as in allied species, relatively short-lived but suited for wind dissemination. It could travel readily on living plants and is believed to have been distributed in Europe by the horticultural trade of Holland.	

Disease	Host plants	Probable country of origin	Distribution and extension	How spread	Remarks
(39) Blister Blight of Azalea (*Exobasidium* sp.).—*contd.*	*Azalea indica* ..	Probably Japan..	Japan, while in England it has been referred to *E. japonicum*. This species was described by Shirai in 1896 in Japan.		
(40) Tomato leaf spot (*Septoria Lycopersici* Speg.).	Tomato ..	South America ..	First described from South America (the native home of the tomato) by Spegazzini in the Argentine in 1884. Is believed to have appeared in Europe shortly after the introduction of the tomato into cultivation. It was known in Italy between 1888 and 1891; Hungary 1902-03. France and Germany (Hamburg) 1905. It was first reported in England in 1908, when it was said that it had damaged the crop in Gloucestershire the previous year. In the report it is said that there is little doubt it was introduced from abroad with cultivated tomatoes. Noted first in the United States (New Jersey) about 1893 and Ohio in 1896. Is now a destructive disease east of the Mississippi. Reported in Australia 1910 XI.	Is abundantly provided with spores. Could travel on living plants and very probably also in packings. The spores might perhaps also get mingled with the seed and travel with it. It does not seem to be known how long they live, but several allied species have fairly long-lived spores.	/2 / 1902-3
(41) Celery leaf spot (*Septoria Petroselini* Desm. var. *Apii* Br. & Cav.)	Celery ..	Old World ..	The fungus was first described in 1890 from the Botanic Garden, Pavia, Italy. It was recorded in 1891 in the United	Is well provided with spores for short-distance spread. Has been widely disseminated on seed, as abun-	

			States (New Jersey and Delaware). Probably recorded in Bavaria as *Phlyctæna Magnusiana* (All.) Bres. in 1891. Elsewhere in Germany in 1895, and spread rapidly. Belgium 1898; Norway from at least 1899; England 1906. Also known in France. South America as *Septoria apiicola* on *Apium australe*, (Spegazzini "Fungi Fuegiana") 1882. Australia, 1910-11. Formosa, 1914.	dantly established in the past few years. Was found on wild celery in Ireland in 1913 and suggested that it originally spread from the wild to the cultivated plant. Wild celery is found in Europe, North Africa, Western Asia and North-West India, so that spread to the cultivated plant might have occurred throughout a wide area.
(42) Anthracnose of Melon, Cucumber and Vegetable Marrow (*Colletotrichum oligochætum* Cav.).	Melon, Cucumber, Vegetable Marrow, *Lagenaria vulgaris*, &c.	....	First described under this name from Lombardy in 1889. It is, however, very doubtful whether the fungus is not identical with *Glœosporium Lagenarium* (Pass.) Sacc. & Roum., which has been long known on the same hosts and attracted notice in England in 1876 (*Gard. Chron.* 1876, II, pp. 175, 269, 303, 336, 400, 495). *Colletotrichum oligochætum* was next recorded in France in 1894. In 1912, it was reported as a new disease in England (*Journ. Board of Agric.*, XVIII, p. 670). The anthracnose due to *Glœosporium Lagenarium* is widely distributed in Europe and the United States, and has been recorded from Formosa in 1914.	Only summer spores are known. In America conflicting results have been obtained in cross-inoculations with this fungus and that found in bean anthracnose (*Glomerella cingulata* (Stonem.) S. & v.S.). The most recent workers regard them as probably distinct species, but if they are proved to be identical then the parasite is of practically world-wide distribution. *Glomerella cingulata* can attack a very large number of plants in all parts of the world, and there is no evidence that it has been recently introduced into Europe, Asia or America. There is, therefore, much doubt whether this is really a new disease in England or indeed anywhere else.

APPENDIX II.

International Phytopathological Convention of Rome.

Article 1.—The contracting States agree to take the necessary legislative and administrative measures to ensure common and efficacious action against the introduction and extension of enemies of plants.

These measures should especially have regard to : (1) the efficacious supervision of nurseries, gardens, green-houses, and other establishments engaged in trade in living plants (plants, cuttings, grafts, flowering bulbs, and cut flowers) ; (2) the recording of the appearance of diseases of plants and of injurious animals with the localities infected ; (3) the means of checking and preventing the diseases of plants ; (4) the regulation of the transport and packing of the plants and parts of plants mentioned above ; (5) the measures to be taken in case of a breach of the regulations.

Article 2.— There shall be created in each State adhering to the present Convention a government service of Phytopathology intended to secure the execution of these measures.

The government service of Phytopathology will comprise as a minimum : (1) the creation of one or more establishments for study and for scientific and technical research ; (2) the organisation of effective supervision of the growing plants ; (3) the inspection of consignments ; (4) the issue of phytopathological certificates.

Article 3.—The measures indicated in paragraphs 2, 3, and 4 of Article 2 shall be already in force at the moment of ratification of or of adherence to the present Convention.

All other measures indicated in Articles 1 and 2 shall be taken in each State within a period of two years from the date of ratification of or of adherence to the present Convention.

Article 4.— The present Convention shall not apply to the vine, to grains and seeds, to edible tubers, bulbs, rhizomes and roots, to fruit and vegetables, to roots and produce of field cultivation.

Article 5.—In order to protect contracting States against the introduction and the extension of plant enemies, these States pledge themselves not to allow the importation of living plants (plants, cuttings, grafts, flowering bulbs, and cut flowers) unless they are accompanied by the Phytopathological certificate issued by competent official agents of the exporting country.

Article. 6.—The importation of the plants referred to in the preceding Article can only take place through Custom Houses of which a list shall have been drawn up by the importing country and communicated to the exporting country.

Article 7.—Each country reserves its right to inspect plants or fresh debris imported.

In case the consignment of plants is found to be infected contrary to the indications of the certificate, the importing country shall immediately advise the Government of the exporting country, which will take the measures provided in its regulations.

The infected produce will be returned to the point of departure at the expense of the proper persons or destroyed by fire if required by the importer ; in this last case, a report shall be transmitted to the Government of the exporting country.

Article 8.—The certificates shall be in the form appended to this Convention and drawn up in two languages : that of the exporting country and French.

Article 9.—Notwithstanding the above stipulations, the importation of living plants is permitted in the interest of scientific research, even without a certificate, on condition that their destination is a scientific institution duly authorised by the Government of the importing country and that the state of the consignment offers every guarantee against the escape of parasites.

States with adjoining frontiers may make mutual arrangements to facilitate the exchange of plants in frontier zones.

Article 10.—The several contracting States are invited to furnish to the International Institute of Agriculture, Rome, at the moment of ratification of or of adherence to the present Convention, a list as restricted as possible of the enemies of plants against which they wish to protect themselves and which must appear on the respective certificates. These lists will be compiled according to the following principles :—

A.—In the enumeration of the enemies of plants common species of long-standing dispersion extending to nearly all countries will be excluded.

The same will be the case with enemies of plants whose ordinary supports do not exist in the importing countries.

B.—In specifying the enemies of plants which are to figure on the lists, the choice will be limited to those presenting—

(1) An epidemic character.

(2) A destructive or at least very harmful action on cultivated plants.

(3) An easy propagation by living plants or parts of living plants.

Article 11.—The creation of the government service of Phytopathology shall be notified by each contracting State to the International Institute of Agriculture, Rome.

Article 12.—The contracting States recognise, from the time of signing the present Convention, the International Institute of Agriculture, Rome, to be the official international centre for all questions relating to the enemies of plants.

The Institute shall collect statistical data as well as administrative, scientific, and practical information concerning all diseases and enemies of plants, through the medium of documents which shall be communicated to it as soon as possible by the government services of Phytopathology and the establishments for Phytopathological Research placed under the authority and control of the several Governments.

Article 13.—The International Institute of Agriculture shall publish, at least once a month, the administrative, scientific, and practical information transmitted to it.

Article 14.—Any proposal from a contracting State tending to modify or amplify the present Convention shall be communicated by that State to the Institute and referred by the latter to a meeting of special Delegates of the contracting parties which shall be called together on the occasion of a General Assembly of the Institute.

The proposals studied by these special Delegates will then be submitted by the General Assembly for the approval of the States which have adhered to the present Convention.

Article 15.—In case of disagreement between two or more contracting States as to the interpretation of the clauses of this Convention, and in case of practical difficulties in its application, the parties concerned undertake to submit their differences to the examination of a special joint Commission appointed from their Phytopathological services so that measures calculated to settle these differences may be proposed.

Article 16.—States bound by the present Convention shall not treat non-contracting States more favourably than contracting States.

Article 17.—The present Convention shall be signed and ratified as soon as possible and the ratifications shall be deposited with the Italian Government as soon as at least three contracting States are in a position to do so.

Each ratification shall be communicated by the Italian Government to the other contracting States as well as to the International Institute of Agriculture.

Article 18.—States which have not signed the present agreement shall be allowed to adhere on their request.

Colonies shall be permitted to adhere on the same conditions as independent States, at the request of the States of which they are dependencies.

Article 19.—Adherence shall be notified through diplomatic channels to the Italian Government and by the latter to the contracting Governments as well as to the International Institute of Agriculture.

Article 20.—Ratification or adherence shall be accompanied by a formal declaration that the State possesses at least the services indicated in paragraphs 2, 3, and 4 of Article 2.

The present Convention will become effective : for the first three States at least which shall have ratified it, in a period of three months from the date of ratification ; for other States, in a period of six months from the deposit with the Italian Government of their ratification or adherence.

Article 21.—If it should happen that a contracting State wishes to denounce the present Convention, either for the whole of its territories or only for all or a part of its colonies, the denunciation shall be notified to the Italian Government which shall immediately communicate a true copy of the notification to all the other States informing them of the date on which it has been received.

The denunciation will only have effect in regard to the State which shall have notified it or of such colonies as are indicated in the act of denunciation, and that only one year after the notification shall have been received by the Italian Government.

FORM OF CERTIFICATE.

* International Phylloxera Convention of Berne and International Phytopathological Convention of Rome.

Certificate for consignments of horticultural plants. (*Each statement on the Certificate to be accompanied by a translation in French*).

Name of Exporting Country.

I.—Declaration of the Exporter.

The undersigned (1) .....

declares :—

A. That the plants (2).....

contained in (3).....packages, marked (4).....

..... addressed to (5).....

in (6) .....have been produced entirely from his establishment or from other establishments under inspection by the Phytopathological service ;

*B. That this consignment contains no vines ;

*C. That the plants are packed (7).....
earth.

(8).....the .....day of.....19

Consignment from (9).....

* Establishments entered in the list compiled in conformity with Article 9 §6 of the Berne Convention on Phylloxera, under the No . . . . . (10)

†II.—Attestation of the Administrative Authority.[1]

The administrative authority attests :—

A. That the above consignment of plants comes from ground separated from any vine plant by a space of at least 20 metres,

(1) Name, firm, profession and address.; (2) Kinds and quantity of plants.; (3) Number of packages. ; (4) Mark and number. ; (5) Complete address of the consignee, name, profession, domicile ; (6) Name of the importing country ; (7) Mention if the plants are packed *with* or *without* earth. ; (8) Place of departure. ; (9) Signature of the exporter. ; (10) Enter the number under which the establishment is entered in the general list.

*Only required for States adhering to the Berne Convention.

†This certificate is only required for countries adhering to the Berne Convention and then only in case the establishment does not figure on the list published in virtue of Article 9, § 6 of the Berne Convention.

[1] Burgomaster, Mayor, or other competent authority according to the country.

or by an obstacle to the roots judged sufficient by the competent authority ;

B. That this ground does not itself contain any vine plants ;

C. That no deposit of vines has been made on this ground ;

D. That there has never been an infection of Phylloxera in the plantation or enclosure ;

E. If there have been any phylloxerised vines, that radical extraction has been done and that poisoning and repeated investigation during three consecutive years, have assured the complete destruction of the insect and of the roots.

.....the (Date).....

Seal of the competent authority.

.....

(Signature.)

III.—Certificate of Phytopathological Inspection.

The undersigned, Inspector of the Phytopathological service (1)..... .....certifies that the consignment indicated in the declaration of the exporter (2)..... of.....and coming from cultures situated at.....is according to the results of the inspection (3) $\frac{\text{of the growing plants,}}{\text{of the transported produce}}$, in a satisfactory sanitary condition and that it is free from the enemies of plants enumerated below (4) |

(Date).....

Seal.

.....

(Signature.)

(1) Name in full, official designation and address of the inspecting officer.

(2) Name in full and domicile of the exporter.

(3) Delete where necessary the mode of inspection not employed.

(4) Complete by the list of the enemies of plants, enumerated in the official list of the importing country, which could exist in the consignment.

PUBLICATIONS OF THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA.

TO BE HAD FROM

THE OFFICE OF THE AGRICULTURAL ADVISER TO THE GOVERNMENT OF INDIA, PUSA, BIHAR;

and from the following Agents :—

(1) THACKER, SPINK & CO., CALCUTTA.
(2) W. NEWMAN & CO., CALCUTTA
(3) RAI M. C. SARKAR BAHADUR & SONS, CALCUTTA.
(4) HIGGINBOTHAMS, LTD., MADRAS.
(5) THOMPSON & CO., MADRAS.
(6) D. B. TARAPOREVALA, SONS & CO BOMBAY.
(7) THACKER & CO., LTD., BOMBAY.
(8) SUNDER PANDURUNG, BOMBAY.
(9) RAI SAHIB M. GULAB SINGH & SONS, LAHORE.
(10) MANAGER EDUCATIONAL BOOK DEPOT, NAGPUR.

Annual Report of the Imperial Department of Agriculture in India for the year 1904-05. Price, As. 12 or 1*s.* 2*d.* (*Out of print.*)

Report of the Imperial Department of Agriculture in India for the years 1905-06 and 1906-07. Price, As. 6 or 7*d.*

Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), for the years 1907—09. Price, As. 4 or 5*d.*

Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), for the year 1909-10. Price, As. 4 or 5*d.*

Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), for the year 1910-11. Price, As. 6 or 7*d.*

Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), for the year 1911-12. Price, As. 6 or 7*d.*

Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), for the year 1912-13. Price, As. 7 or 8*d.*

Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), for the year 1913-14. Price, As. 8 or 9*d.*

Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), for the year 1914-15. Price, As. 8 or 9*d.*

Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), for the year 1915-16. Price, As. 6 or 7*d.*

Report on the Progress of Agriculture in India for the years 1907—09. Price, As. 6 or 7*d.*

Report on the Progress of Agriculture in India for the year 1909-10. Price, As. 6 or 7*d.*

Report on the Progress of Agriculture in India for the year 1910-11. Price, As. 12 or 1*s.* 3*d.* (*Out of print.*)

Report on the Progress of Agriculture in India for the year 1911-12. Price, As. 6 or 7*d.*

Report on the Progress of Agriculture in India for the year 1912-13. Price, As. 8 or 9*d.*

Report on the Progress of Agriculture in India for the year 1913-14. Price, As. 8 or 9*d.*

Report on the Progress of Agriculture in India for the year 1914-15. Price, As. 5 or 6*d.*

Proceedings of the Board of Agriculture in India, held at Pusa on the 6th January 1905 and following days (with Appendices). Price, As. 8 or 9*d.*

Proceedings of the Board of Agriculture in India, held at Pusa on the 15th January 1906 and following days (with Appendices). Price, As. 12 or 1*s.* 2*d.*

Proceedings of the Board of Agriculture in India, held at Cawnpore on the 18th February 1907 and following days (with Appendices). Price, R. 1-2 or 1*s.* 6*d.*

Proceedings of the Board of Agriculture in India, held at Pusa on the 17th February 1908 and following days (with Appendices). Price, As. 8 or 9*d.*

Proceedings of the Board of Agriculture in India, held at Nagpur on the 15th February 1909 and following days (with Appendices). Price, As. 8 or 9*d.*

Proceedings of the Board of Agriculture in India, held at Pusa on the 21st February 1910 and following days (with Appendices). Price, As. 8 or 9*d.*

Proceedings of the Board of Agriculture in India, held at Pusa on the 20th November 1911 and following days (with Appendices). Price, As. 10 or 1*s.* (*Out of print.*)

Proceedings of the Board of Agriculture in India, held at Coimbatore on the 8th December 1913 and following days (with Appendices). Price, R. 1-2 or 1*s.* 9*d.*

Proceedings of the Board of Agriculture in India, held at Pusa on the 7th February 1916 and following days (with Appendices). Price, R. 1-2 or 1*s.* 9*d.*

Proceedings of the Inter-Provincial Jute Conference, held at Calcutta from the 2nd to 4th August s of h (with Appendices). Price, As. 6 or 7*d.*

Standard Curriculum for Provincial Agricultural Colleges as recommended by the Board of Agriculture, 1908. Price, As. 4 or 5*d.*

The *Agricultural Journal of India.* A Quarterly Journal dealing with subjects connected with agricultural economics, field and garden crops, economic plants and fruits, soils, manures, methods of cultivation, irrigation, climatic conditions, insect pests, fungus diseases, co-operative credit, agricultural cattle, farm implements and other agricultural matters in India. Illustrations, including coloured plates, form a prominent feature of the Journal. It is edited by the Agricultural Adviser to the Government of India, with the assistance of the Staff of the Pusa Agricultural Research Institute. *Annual subscription*, Rs. 6 or 8*s.* 6*d.*, including postage. Single copy, Rs. 2 or 3 shillings.

MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA are issued from time to time as matter is available, in separate series, such as Chemistry, Botany, Entomology, and the like.

BOTANICAL SERIES.

Vol. I, No. I. Studies in Root-Parasitism. The Haustorium of *Santalum album.*—PART I.—Early Stages, up to Penetration, by C. A. BARBER, M.A., F.L.S. Price, R. 1. (*Out of print.*)
Part II.—The Structure of the Mature Haustorium and the Inter-relations between Host and Parasite, by C. A. BARBER, M.A., F.L.S. Price, Rs. 3. (*Out of print.*)

Vol. I, No. II. Indian Wheat Rusts, by E. J. BUTLER, M.B., F.L.S. ; and J. M. HAYMAN, D.V.S. Price, Rs. 3. (*Out of print.*)

Vol. I, No. III. Fungus Diseases of Sugarcane in Bengal, by E. J. BUTLER, M.B., F.L.S. Price, Rs. 3. (*Out of print.*)

Vol. I, No. IV. *Gossypium obtusifolium*, Roxburgh, by I. H. BURKILL, M.A. Price, R. 1.

Vol. I, No. V. An Account of the Genus *Pythium* and some *Chytridiaceæ*, by E. J. BUTLER, M.B., F.L.S. Price, Rs. 4-8. (*Out of print.*)

Vol. I, No. VI. *Cephaleuros virescens*, Kunze: The Red Rust of Tea, by HAROLD H. MANN, D.Sc., F.L.S.; and C. M. HUTCHINSON, B.A. Price, Rs. 4. (*Out of print.*)

Vol. II, No. I. Some Diseases of Cereals caused by *Sclerospora graminicola*, by E. J. BUTLER, M.B., F.L.S. Price, R. 1-8.

Vol. II, No. II. The Indian Cottons, by G. A. GAMMIE, F.L.S. Price, Rs. 7-8. (*Out of print.*)

Vol. II, No. III. Note on a Toxic Substance excreted by the Roots of Plants, by F. FLETCHER, M.A., B.Sc. Price, R. 1-8.

Vol. II, No. IV. Studies in Root-Parasitism. Part III.—The Haustorium of *Olax scandens*, by C. A. BARBER, M.A., F.L.S. Price, Rs. 2-8.

Vol. II, No. V. Studies in Root-Parasitism. Part IV.—The Haustorium of *Cansjera Rheedii*, by C. A. BARBER, M.A., F.L.S. Price, Rs. 2-8. (*Out of print.*)

Vol. II, No. VI. Some Experiments in the Hybridizing of Indian Cottons, by P. F. FYSON, B.A., F.L.S. Price, R. 1-8. (*Out of print.*)

Vol. II, No. VII. The Varietal Characters of Indian Wheats, by ALBERT HOWARD, M.A., F.L.S.; and GABRIELLE L. C. HOWARD, M.A. Price, R. 1. (*Out of print.*)

Vol. II, No. VIII. The Mulberry Disease caused by *Coryneum mori*, Nom., in Kashmir, with Notes on other Mulberry Diseases, by E. J. BUTLER, M.B., F.L.S. Price, R. 1-8. (*Out of print.*)

Vol. II, No. IX. The Wilt Disease of Pigeon-Pea and the Parasitism of *Neocosmospora vasinfecta*, Smith, by E. J. BUTLER, M.B., F.L.S. Price, Rs. 3.

BOTANICAL SERIES—*contd.*

Vol. III, No. I. Studies in Indian Tobaccos, No. 1.—The Types of *Nicotiana rustica*, L., Yellow Flowered Tobacco, by ALBERT HOWARD, M.A., A.R.C.S., F.L.S.; and GABRIELLE L. C. HOWARD, M.A. Price, Rs. 4.

Vol. III, No. II. Studies in Indian Tobaccos, No. 2.—The Types of *Nicotiana tabacum*, L., by ALBERT HOWARD, M.A., A.R.C.S., F.L.S.; and GABRIELLE L. C. HOWARD, M.A. Price, Rs. 9.

Vol. III, No. III. Studies in Indian Fibre Plants, No. 1.—On two Varieties of Sann. *Crotalaria juncea*, L., by ALBERT HOWARD, M.A., A.R.C.S., F.L.S.; and GABRIELLE L. C. HOWARD, M.A. Price, R. 1.

Vol. III, No. IV. The Influence of the Environment on the Milling and Baking Qualities of Wheat in India, No. 1.—The Experiments of 1907-08 and 1908-09, by ALBERT HOWARD, M.A., F.L.S.; H. MARTIN LEAKE, M.A., F.L.S.; and GABRIELLE L. C. HOWARD, M.A. Price, R. 1-8.

Vol. III, No. V. The Bud-Rot of Palms in India, by E. J. BUTLER, M.B., F.L.S. Price, Rs. 2.

Vol. III, No. VI. The Economic Significance of Natural Cross-fertilization in India, by ALBERT HOWARD, M.A., A.R.C.S., F.L.S.; GABRIELLE L. C. HOWARD, M.A.; and ABDUR RAHMAN KHAN. Price, Rs. 4-8.

Vol. IV, No. I. Millets of the Genus *Setaria* in the Bombay Presidency and Sind, by G. A. GAMMIE, F.L.S. Price, R. 1.

Vol. IV, No. II. Studies in Indian Fibre Plants, No. 2.—On Some New Varieties of *Hibiscus cannabinus*, L., and *Hibiscus Sabdariffa*, L., by ALBERT HOWARD, M.A., A.R.C.S., F.L.S.; and GABRIELLE L. C. HOWARD, M.A. Price, Rs. 3.

Vol. IV, No. III. Notes on the Incidence and Effect of Sterility and of Cross-fertilization in the Indian Cottons, by H. MARTIN LEAKE, M.A.; and RAM PRASAD. Price, R. 1.

Vol. IV, No. IV. The Inheritance of Red Colour and the regularity of Self-fertilization in *Corchorus capsularis*, Linn., the common Jute Plant, by R. S. FINLOW, B.Sc.; and I. H. BURKILL, M.A., F.L.S., Price, R. 1.

Vol. IV, No. V. Observations on Certain Extra-Indian Asiatic Cottons, by H. MARTIN LEAKE, M.A., and RAM PRASAD. Price, R. 1-8.

Vol. IV, No. VI. The Morphology and Parasitism of *Rhizoctonia*, by F. J. F. SHAW, B.Sc., A.R.C.S., F.L.S. Price, Rs. 2.

Vol. V, No. I. On the Inheritance of some Characters in Wheat—I, by ALBERT HOWARD, M.A., A.R.C.S., F.L.S.; and GABRIELLE L. C. HOWARD, M.A. Price, R. 1.

Vol. V, No. II. The Influence of the Environment on the Milling and Baking Qualities of Wheat in India, No. 2.—The Experiments of 1909-10 and 1910-11, by ALBERT HOWARD, M.A., F.L.S.; H. MARTIN LEAKE, M.A., F.L.S.; and GABRIELLE L. C. HOWARD, M.A. Price, R. 1.

Vol. V, No. III. The Varieties of Soy Beans found in Bengal, Bihar and Orissa, and their Commercial Possibilities, by E. J. WOODHOUSE, M.A. F.L.S.; and C. SOMERS-TAYLOR, B.A. Price, Rs. 2.

Vol. V, No. IV. On *Phytophthora parasitica*, nov. spec. A new Disease of the Castor Oil Plant, by J. F. DASTUR, B.Sc. Price, Rs. 2.

Vol. V, No. V. Studies in *Peronosporaceæ*, by E. J. BUTLER, M.B., F.L.S.; and G. S. KULKARNI, L.Ag. Price, Rs. 2.

Vol. VI, No. I. Notes on Pollination and Cross-fertilization in the common Rice Plant, *Oryza sativa*, Linn., by G. P. HECTOR, M.A., B.Sc. Price, R. 1.

Vol. VI, No. II. A Sclerotial Disease of Rice, by F. J. F. SHAW, B.Sc., A.R.C.S., F.L.S. Price, R. 1.

Vol. VI, No. III. Studies in Indian Tobaccos, No. 3.—The Inheritance of Characters in *Nicotiana tabacum*, L., by GABRIELLE L. C. HOWARD, M.A. Price, Rs. 3.

Vol. VI, No. IV. Studies in Indian Cottons, Part I.—The Vegetative Characters, by H. MARTIN LEAKE, M.A., F.L.S.; and RAM PRASAD. Price, Rs. 3-8.

Vol. VI, No. V. Red Rot of Sugarcane, by E. J. BUTLER, M.B., F.L.S.; and ABDUL HAFIZ KHAN. Price, R. 1.

Vol. VI, No. VI. Some New Sugarcane Diseases, by E. J. BUTLER, M.B., F.L.S.; and ABDUL HAFIZ KHAN. Price, Rs. 2.

Vol. VI, No. VII. A Preliminary Note on the Classification of Rice in the Central Provinces, by R. J. D. GRAHAM, M.A., B.Sc. Price, R. 1-8.

Vol. VI, No. VIII. The Influence of the Environment on the Milling and Baking Qualities of Wheat in India, No. 3.—The Experiments of 1911-12, by ALBERT HOWARD, C.I.E., M.A.; H. MARTIN LEAKE, M.A.; and GABRIELLE L. C. HOWARD, M.A. Price, R. 1 or 1*s.* 6*d.*

BOTANICAL SERIES—*concld.*

Vol. VII, No. I. Studies in Indian Sugarcanes, No. 1, Punjab canes, by C. A. BARBER, SC.D. Price, Rs. 3-8 or 5*s.* 6*d.*

Vol. VII, No. II. The Distinguishing Characters of Sugarcanes cultivated at Sabour, by E. J. WOODHOUSE, M.A.; and S. K. BASU, M.A.; with a Note on the Chemical Characters by C. SOMERS TAYLOR, B.A. Price, R. 1-8 or 2*s.* 6*d.*

Vol. VII, No. III. The Potato Blight in India, by J. F. DASTUR, B.SC. Price, R. 1 or 1*s.* 6*d.*

Vol. VII, No. IV. The Genus *Rhizoctonia* in India, by F. J. F. SHAW, B.SC.; and S. L. AJREKAR, B.A., Dip. Agr. (Cantab.) Price, R. 1 or 1*s.* 6*d.*

Vol. VII, No. V. Experiments on the Physiology of Indigo-yielding Glucosides, by F. R. PARNELL, B.A. Price, R. 1 or 1*s.* 6*d.*

Vol. VII, No. VI. Some Varieties of Indian Gram (*Cicer arietinum*, L.), by ALBERT HOWARD, C.I.E., M.A.; GABRIELLE L. C. HOWARD, M.A.; and ABDUR RAHMAN KHAN. Price, R. 1 or 1*s.* 6*d.*

Vol. VII, No. VII. Studies in Indian Oil-Seeds, No. 1, Safflower and Mustard, by ALBERT HOWARD, C.I.E., M.A.; GABRIELLE L. C. HOWARD, M.A.; and ABDUR RAHMAN KHAN. Price, R. 1-8 or 2*s.* 6*d.*

Vol. VII, No. VIII. On the Inheritance of some Characters in Wheat—II, by ALBERT HOWARD, C.I.E., M.A.; and GABRIELLE L. C. HOWARD, M.A. Price, R. 1-8 or 2*s.* 6*d.*

Vol. VIII, No. I. The Wheats of Baluchistan, Khorasan and the Kurram Valley, by GABRIELLE L. C. HOWARD, M.A. Price, R. 1-12 or 2*s.* 6*d.*

Vol. VIII, No. II. Observations on the Inheritance of Anthocyan Pigment in Paddy Varieties, by G. P. HECTOR, M.A., B.SC. Price, R. 1 or 1*s.* 6*d.*

Vol. VIII, No. III. Studies in Indian Sugarcanes, No. 2, Sugarcane Seedlings, including some correlations between Morphological Characters and Sucrose in the juice, by C. A. BARBER, SC.D. Price, Rs. 3 or 4*s.* 3*d.*

Vol. VIII, No. IV. Pollination and Cross-fertilization in the *Juar* plant, by R. J. D. GRAHAM, M.A., B.SC. Price, R. 1 or 1*s.* 6*d.*

Vol. VIII, No. V. *Phytophthora* sp. on *Hevea Brasiliensis*, by J. F. DASTUR, B.SC. Price, As. 12 or 1*d.*

Vol. VIII, No. VI. *Phytophthora* on *Vinca rosea*, by J. F. DASTUR, B.SC. Price, As. 8 or 9*d.*

CHEMICAL SERIES.

Vol. I, No. I. The Composition of Indian Rain and Dew, by J. WALTER LEATHER, PH.D., F.I.C. Price, R. 1.

Vol. I, No. II. The Composition of the Oil-Seeds of India, by J. WALTER LEATHER, PH.D., F.I.C. Price, R. 1. (*Out of print.*)

Vol. I, No. III. The Pot-Culture House at the Agricultural Research Institute, Pusa, by J. WALTER LEATHER, PH.D., F.I.C. Price, Rs. 3.

Vol. I, No. IV. Experiments on the Availability of Phosphates and Potash in Soils, by J. WALTER LEATHER, PH.D., F.I.C. Price, R. 1-8.

Vol. I, No. V. The Construction of Drain Gauges at Pusa, by M. H. ARNOTT, M.INST.C.E., with a Preface by J. WALTER LEATHER, PH.D., F.I.C. Price, Rs. 3. (*Out of print.*)

Vol. I, No. VI. The Loss of Water from Soil during Dry Weather, by J. WALTER LEATHER, PH.D., F.I.C. Price, Rs. 2. (*Out of print.*)

Vol. I, No. VII. The System Water, Calcium Carbonate, Carbonic Acid, by J. WALTER LEATHER, PH.D., F.I.C.; and JATINDRA NATH SEN, M.A. Price, R. 1.

Vol. I, No. VIII. Water Requirements of Crops in India—I, by J. WALTER LEATHER, PH.D., F.I.C. Price, Rs. 3.

Vol. I, No. IX. The Nature of the Colour of Black Cotton Soil, by H. E. ANNETT, B.SC. Price, R. 1.

Vol. I, No. X. Water Requirements of Crops in India,—II, by J. WALTER LEATHER, PH.D., F.I.C. Price, Rs. 2-8.

Vol. II, No. I. The Composition of the Milk of some Breeds of Indian Cows and Buffaloes and its Variations, Part I. The Milk of some Breeds of Indian Cows, by A. A. MEGGITT, B.SC.; and HAROLD H. MANN, D.SC. Price, R. 1-8.

Vol. II, No. II. Records of Drainage in India, by J. WALTER LEATHER, PH.D., F.I.C. Price, R. 1.

Vol. II, No. III. The *Rab* System of Rice Cultivation in Western India, by HAROLD H. MANN, D.SC.; N. V. JOSHI, B.A., B.SC., L.AG.; and N. V. KANITKAR, B.AG. Price, R. 1.

Vol. II, No. IV. The Composition of the Milk of some Breeds of Indian Cows and Buffaloes and its Variations, Part I. The Milk of some Breeds of Indian Buffaloes, by A. A. MEGGITT, B.SC.; and HAROLD H. MANN, D.SC. Price, R. 1-8.

Vol. II, No. V. A contribution to the knowledge of the Black Cotton Soils of India, by W. H. HARRISON, M.SC.; and M. R. RAMSWAMY SIVAN, B.A. Price, R. 1.

II, No. VI. The Date Sugar Industry in Bengal, an Investigation into its Chemistry and Agriculture, by H. E. ANNETT, B.SC., assisted by G. K. LELE, L.AG.; and BHAILAL M. AMIN, B.A. Price, Rs. 3.

CHEMICAL SERIES—*concld.*

Vol. III, No. I. Evaporation from a Plain Water Surface, by J. WALTER LEATHER, Ph.D., F.I.C. Price, R. 1.

Vol. III, No. II. Studies in the Chemistry and Physiology of the Leaves of the Betel-vine (*Piper betle*) and of the Commercial Bleaching of Betel-vine Leaves, Part I, by HAROLD H. MANN, D.Sc.; D. L. SAHASRABUDDHE, B.Sc., L.Ag.; and V. G. PATWARDHAN, B.Ag. Price, R. 1-8.

Vol. III, No. III. The Gases of Swamp Rice Soils, Part I. Their Composition and Relationship to the Crop, by W. H. HARRISON, M.Sc.; and P. A. SUBRAMANIA AIYER, B.A. Price, R. 1-8.

Vol. III, No. IV. The Experimental Error in Sampling Sugarcane, by J. WALTER LEATHER, V.D., Ph.D., F.I.C. Price, R. 1.

Vol. III, No. V. The Fractional Liquefaction of Rice Starch, by F. J. WARTH, M.Sc.; and D. B. DARABSETT, B.Sc. Price, R. 1.

Vol. III, No. VI. The Yield and Composition of the Milk of the Montgomery herd at Pusa and Errors in Milk Tests, by J. WALTER LEATHER, V.D., Ph.D., F.I.C.; and A. C. DOBBS. Price, R. 1 or 1*s.* 6*d.*

Vol. III, No. VII. The System Potassium Nitrate, Sodium Chloride, Water, by J. WALTER LEATHER, V.D. Ph.D., F.I.C.; and JATINDRA NATH MUKERJEE, B.A., B.Sc. Price, R. 1 or 1*s.* 6*d*

Vol. III, No. VIII. The Systems—(A) Water, Magnesium Carbonate, and Carbonic Acid, (B) Water, Calcium Carbonate, Magnesium Carbonate, and Carbonic Acid, by J. WALTER LEATHER, V.D., Ph.D., F.I.C.; and JATINDRA NATH SEN, M.A. Price, R. 1 or 1*s.* 6*d.*

Vol. III, No. IX. Studies of an Acid Soil in Assam, by A. A. MEGGITT, B.Sc. Price, R. 1-8 or 2*s.* 6*d.*

Vol. IV, No. I. The Gases of Swamp Rice Soils, Part II. Their Utilization for the Aëration of the Roots of the Crop, by W. H. HARRISON, M.Sc.; and P. A. SUBRAMANIA AIYER, B.A. Price, R. 1 or 1*s.* 6*d.*

Vol. IV, No. II. Soil Temperatures, by J. WALTER LEATHER, V.D., F.I.C. Price, Rs. 2 or 3*s.*

Vol. IV, No. III. Soil Gases, by J. WALTER LEATHER, V.D., F.I.C. Price, R. 1-8 or 2*s.* 6*d.*

Vol. IV, No. IV. The Gases of Swamp Rice Soils, Part III. A Hydrogen-oxidizing Bacterium from these Soils, by W. H. HARRISON, D.Sc.; and P. A. SUBRAMANIA AIYER, B.A. Price, As. 12 or 1*s.*

Vol. IV, No. V. Some Factors affecting the Cooking of Dholl (*Cajanus indicus*), by B. VISWANATH; T LAKSHMANA ROW, B.A.; and P. A. RAGHUNATHSWAMI AYYANGAR, D.A. Price, R. 1 or 1*s.* 6*d.*

Vol. IV, No. VI. The Insects attacking Stored Wheat in the Punjab and the Methods of Combating them (including a Chapter on the Chemistry of Respiration), by J. H. BARNES, B.Sc., F.I.C.; and A. J. GROVE, M.Sc. Price, Rs. 3-8 or 5*s.* 6*d.*

Vol. IV, No. VII. Studies in the Chemistry and Physiology of the Leaves of the Betel-vine (*Piper betle*) and of the Commercial Bleaching of Betel-vine Leaves, Part II, by HAROLD H. MANN, D.Sc.; and V. G. PATWARDHAN, B.Ag. Price, R. 1 or 1*s.* 6*d.*

Vol. V, No. I. The Gases of Swamp Rice Soils, Part IV. The Source of the Gaseous Soil Nitrogen, by W. H. HARRISON, D.Sc.; and P. A. SUBRAMANIA AIYER, B.A. Price, Rs. 2 or 3*s.* 6*d.*

ENTOMOLOGICAL SERIES.

Vol. I, No. I. The Bombay Locust (*Acridium succinctum*, Linn.) A Report on the Investigations of 1903-04, by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. Price, Rs. 2-8.

Vol. I, No. II. The more Important Insects injurious to Indian Agriculture, by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. Price, Rs. 3. (*Out of print.*)

Vol. I, No. III. The Indian Surface Caterpillars of the Genus *Agrotis*, by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.; and C. C. GHOSH, B.A. Price, R. 1-8. (*Out of print.*)

Vol. I, No. IV. Individual and Seasonal Variations in *Helopeltis theivora*, Waterhouse, with description of a new species of *Helopeltis*, by HAROLD H. MANN, D.Sc. Price, R. 1-8.

Vol. I, No. V. The *Coccidæ* attacking the Tea Plant in India and Ceylon, by E. E. GREEN, F.E.S., F.Z.S.; and HAROLD H. MANN, D.Sc. Price, R. 1. (*Out of print.*)

Vol. I, No. VI. The Mustard Sawfly (*Athalia proxima*, Klug.), by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.; and C. C. GHOSH, B.A. Price, R. 1. (*Out of print.*)

Vol. II, No. I. The Rice Bug (*Leptocorisa varicornis*, Fabr.), by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. Price, R. 1.

Vol. II, No. II. Remarks on Indian Scale Insects (*Coccidæ*), Part III, by E. E. GREEN, F.E.S., F.Z.S. Price, R. 1-8.

ENTOMOLOGICAL SERIES—*concld.*

Vol. II, No. III. The Red Cotton Bug (*Dysdercus cingulatus*, Fabr.), by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. Price, R. 1. (*Out of print.*)

Vol. II, No. IV. The Castor Semi-Looper (*Ophiusa melicerte*, Dr.), by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. Price, Rs. 2. (*Out of print.*)

Vol. II, No. V. The Tobacco Caterpillar (*Prodenia littoralis*), by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. Price, R. 1-8. (*Out of print.*)

Vol. II, No. VI. The Cotton Leaf-Roller (*Sylepta derogata*, Fabr.), by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. Price, R. 1-8. (*Out of print.*)

Vol. II, No. VII. Notes on Indian Scale Insects (*Coccidæ*), by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. Price, R. 1-8. (*Out of print.*)

Vol. II, No. VIII. Life-Histories of Indian Insects—I. (*Coleoptera*), by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. Price, Rs. 2.

Vol. II, No. IX. Life-Histories of Indian Insects—II. Some Aquatic *Rhynchota* and *Coleoptera*, by D. NOWROJEE, B.A. Price, R. 1-8.

Vol. II, No. X. Life-Histories of Indian Insects—III. The Rhinoceros Beetle (*Oryctes rhinoceros*) and the Red or Palm Weevil (*Rhynchophorus ferrugineus*), by C. C. GHOSH, B.A. Price, Rs. 2.

Vol. III. The Food of Birds in India, by C. W. MASON, M.S.E.A.C., edited by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. Price, Rs. 7-8.

Vol. IV, No. I. Eri Silk, by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.; and C. C. GHOSH, B.A. Price, Rs. 3.

Vol. IV, No. II. Tetriginæ (*Acridiinæ*) in the Agricultural Research Institute, Pusa, Bihar, with descriptions of new species, by J. L. HANCOCK, F.E.S. Price, R. 1.

Vol. IV, No. III. The Big Brown Cricket (*Brachytrypes achatinus*, Stoll), by C. C. GHOSH, B.A. Price, R. 1.

Vol. IV, No. IV. Life-Histories of Indian Insects—IV. (*Hymenoptera*), by G. R. DUTT, B.A. Price, Rs. 2.

Vol. IV, No. V. Inquiry into the Insecticidal Action of some Mineral and other Compounds on Caterpillars, by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.; and R. S. FINLOW, B.Sc. Price, R. 1-8.

Vol. IV, No. VI. The "Psylla" disease of Indigo, by A. J. GROVE, M.Sc.; and C. C. GHOSH, B.A. Price, R. 1-8 or 2*s.* 6*d.*

Vol. V, No. I. Life-Histories of Indian Insects—V. *Lepidoptera* (Butterflies), by C. C. GHOSH, B.A. Price, Rs. 2-8 or 3*s.* 9*d.*

Vol. V, No. II. Indian Sugarcane Leaf-hopper (*Pyrilla aberrans*, Kirby), by C. S. MISRA, B.A. (*In the press.*)

BACTERIOLOGICAL SERIES.

Vol. I, No. I. Studies in Bacteriological Analysis of Indian Soils, No. 1, 1910-11, by C. M. HUTCHINSON, B.A. Price, Rs. 2-8.

Vol. I, No. II. Rangpur Tobacco Wilt, by C. M. HUTCHINSON, B.A. Price, Rs. 2.

Vol. I, No. III. A New Nitrite-forming Organism, by N. V. JOSHI, B.A., B.Sc., L.Ag. Price, R. 1 or 1*s.* 6*d.*

Vol. I, No. IV. Azotobacter and Nitrogen Fixation in Indian Soils, by J. H. WALTON, B.A., B.Sc. Price, R. 1 or 1*s.* 6*d.*

Vol. I, No. V. Bacterial Rot of Stored Potato Tubers, by C. M. HUTCHINSON and N. V. JOSHI, B.A., B.Sc., L.Ag. Price, R. 1 or 1*s.* 6*d.*

Vol. I, No. VI. *Bákhar*—The Indian Rice Beer Ferment, by C. M. HUTCHINSON and C. S. RAM AYYAR, B.A. Price, R. 1 or 1*s.* 6*d.*

VETERINARY SERIES.

Vol. I, No. I. Anaphylaxis in the Larger Animals, by J. D. E. HOLMES, M.A., D.Sc., M.R.C.V.S. Price, Rs. 2.

Vol. I, No. II. Salvarsan in the Treatment of Surra in Horses, Dogs, and Rabbits, by J. D. E. HOLMES, M.A., D.Sc., M.R.C.V.S. Price, R. 1-4.

Vol. I, No. III. Some more Successful Experiments on the Treatment of Surra in the Camel with Recommendations for Systematic Treatment, by A. S. LEESE, M.R.C.V.S. Price, R. 1.

Vol. I, No. IV. On the Immune Bodies occurring in Anti-Rinderpest Serum and on the Variations occurring in the Serum Proteins of Animals during Rinderpest, and during Immunization and Hyper-immunization, by P. HARTLEY, D.Sc. Price, Rs. 2.

VETERINARY SERIES—*concld.*

Vol. II, No. I. Some cases of Surra treated in the Field and in the Laboratory during the Autumn of 1911, by Major J. D. E. HOLMES, M.A., D.SC., Price, R. 1.

Vol. II, No. II. Rinderpest: Further Investigations on Questions connected with the Economical Production of Anti-serum, by J. D. E. HOLMES, M.A., D.SC. Price, R. 1.

ol. II, No. III. The Curative Treatment of Hæmorrhagic Septicæmia in Cattle by the administration of Iodine and other notes on Chemiotherapy in Rinderpest and Hæmorrhagic Septicæmia, by J. D. E. HOLMES, C.I.E., M.A., D.SC., M.R.C.V.S. Price, R. 1 or 1*s.* 6*d.*

Vol. II, No. IV. The Vitality of the Hæmorrhagic Septicæmia Organism outside the body, by J. D. E. HOLMES, C.I.E., M.A., D.SC., M.R.C.V.S. Price, R. 1 or 1*s.* 6*d.*

Vol. II, No. V. Bursati, by J. D. E HOLMES, C.I.E., M.A., D.SC., M.R.C.V.S. Price, R. 1-8 or 2*s.* 3*d.*

Vol. II, No. VI. Experiments on the treatment of Surra in Camels, by H. E. CROSS, M.R.C.V.S., D.V.H., A.SC. Price, R. 1 or 1*s.* 6*d.*

Vol. II, No. VII. Anthrax—Some Experiments on the Immunizing Effect of the Simultaneous Injection of an Anthrax attenuated virus and an Anthrax Anti-serum, by J. D. E. HOLMES, C.I.E., M.A., D.SC., M.R.C.V.S. Price, R. 1 or 1*s.* 6*d.*

BULLETINS ISSUED BY THE AGRICULTURAL RESEARCH INSTITUTE, PUSA.

No. 1. Notes on Cotton in Bihar in 1904, by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. Price, As. 4 or 6*d.*

No. 2. An Outbreak of Cotton Pests in the Punjab, 1905, by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. Price, As. 6 or 7*d.*

No. 3. The Extension of Jute Cultivation in India, by R. S. FINLOW, B.SC. Price, As. 12 or 1*s.* 2*d.* (*Out of print.*)

No. 4. First Report on the Fruit Experiments at Pusa, by ALBERT HOWARD, M.A., A.R.C.S., F.L.S. Price, As. 6 or 6*d.*

No. 5. Report on Trials of the South African Locust Fungus in India, by E. J. BUTLER, M.B., F.L.S.; and H. MAXWELL LEFROY, M.A., F.E.S., F.Z.S. Price, As. 2 or 3*d.*

No. 6. The Ticks Infesting Domesticated Animals in India, by C. WARBURTON, M.A. Price, As. 4 or 6*d.* (*Out of print.*)

No. 7. A Preliminary Account of the Biting Flies of India, by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. Price, R. 1 or 1*s.* 6*d.* (*Out of print.*)

No. 8. Official and Recommended Methods for use in Chemical Laboratories of the Departments of Agriculture in India, by J. WALTER LEATHER, Ph.D., F.I.C. Price, As. 4 or 6*d.*

No. 9. Report on Coconut Palm Disease in Travancore, by E. J. BUTLER, M.B., F.L.S. Price, As. 6 or 6*d.* (*Out of print.*)

No. 10. Treatment and Observation of Crop Pests on the Pusa Farm, by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.; and C. S. MISRA, B.A. Price, As. 6 or 7*d.* (*Out of print.*)

No. 11. On Flax Dodder, by ALBERT HOWARD, M.A., A.R.C.S., F.L.S. Price, As. 4 or 6*d.* (*Out of print.*)

No. 12. The Making and Care of Lawns in India, by ALBERT HOWARD, M.A., A.R.C.S., F.L.S. Price, As. 4 or 6*d.* (*Out of print.*)

No. 13. Sugarcane at the Partabgarh Experimental Station, by G. CLARKE, F.I.C.; and Khan Bahadur S. M. HADI, M.R.A.C., M.R.A.S. (Assisted by S. C. BANERJEE and NAIB HUSSAIN.) Price, As. 6 or 6*d.*

No. 14. The Milling and Baking Qualities of Indian Wheats, No. 1, by ALBERT HOWARD, M.A., A.R.C.S., F.L.S.; and GABRIELLE L. C. HOWARD, M.A. Price, As. 4 or 6*d.*

No. 15. Note on the Extension of Cultivation of Fibre Plants in India. Price, As. 6 or 8*d.*

No. 16. Second Report on the Fruit Experiments at Pusa, by ALBERT HOWARD, M.A., A.R.C.S., F.L.S. Price, As. 6 or 8*d.*

No. 17. The Milling and Baking Qualities of Indian Wheats, No. 2. Some new Pusa Selections tested in 1909, by ALBERT HOWARD, M.A., A.R.C.S., F.L.S.; and GABRIELLE L. C. HOWARD, M.A. Price, As. 6 or 8*d.*

No. 18. Report on the Outbreak of Blister Blight on Tea in the Darjeeling District in 1908-09, by W. MCRAE, M.A., B.SC. Price, R. 1 or 1*s.* 6*d.*

BULLETINS ISSUED BY THE AGRICULTURAL RESEARCH INSTITUTE, PUSA—*contd.*

No. 19. List of Names used in India for Common Insects, compiled in the Laboratory of the Imperial Entomologist, Pusa. Price, As. 12 or 1*s.* 2*d.*

No. 20. Memorandum on Indian Wheat for the British Market (Read before the Incorporated National Association of British and Irish Millers), by Sir JAMES WILSON, K.C.S.I. Price, As. 4 or 6*d.*

No. 21. Memorandum regarding Leading Eucalypts suitable for India, by F. BOOTH-TUCKER. Price, As. 4 or 5*d.* (*Out of print.*)

No. 22. The Milling and Baking Qualities of Indian Wheats, No. 3. Some new Pusa Hybrids tested in 1910, by ALBERT HOWARD, M.A., A.R.C.S., F.L.S.; and GABRIELLE L. C. HOWARD, M.A. Price, As. 7 or 8*d.*

No. 23. Insecticides—Mixtures and Recipes for use against Insects in the Field, the Orchard, the Garden, and the House, by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. Second Edition. Revised, with many additions, by T. BAINBRIGGE FLETCHER, R.N., F.E.S., F.Z.S. Price, As. 12 or 1*s.* 2*d.*

No. 24. The Indian Saltpetre Industry, by J. WALTER LEATHER, Ph.D., F.I.C.; and J. N. MUKERJI, B.A., B.Sc. Price, As. 8 or 9*d.*

No. 25. Report on the Flax Experiments conducted at Dooriah during the year 1910-11, by E. M. VANDEKERKHOVE. Price, As. 6 or 7*d.*

No. 26. Note on the Present Position of Cotton Investigation in India, by BERNARD COVENTRY, C.I.E. Price, As. 2 or 3*d.*

No. 27. Experiments on the Cultivation of Sugarcane at the Partabgarh Experiment Station, 1909—11, by G. CLARKE, F.I.C.; H. E. ANNETT, B.Sc.; and SYED ZAMIN HUSSAIN, B.A. (Assisted by S. C. BANERJEE and NAIB HUSSAIN.) Price, As. 5 or 6*d.*

No. 28. The Cultivation of Lac (*Tachardia lacca*, Kerr.), in the Plains of India by C. S. MISRA, B.A. (Revised Edition.) Price, As. 8 or 9*d.*

No. 29. Directions for the Cultivation of Eri Silk. (Revised Edition.) Price, As. 3 or 4*d.*

No. 30. Report on the Flax Experiments conducted at Dooriah during the year 1911-12, by E. M. VANDEKERKHOVE. Price, A. 1-6 or 2*d.*

No. 31. Wheat Experiments on the Botanical Area, Cawnpore, and their bearing on Wheat Cultivation in the United Provinces, by H. MARTIN LEAKE, M.A., F.L.S.; and RAMPRASAD. Price, As. 3 or 4*d.*

No. 32. A Note on some Interesting Results foll wing the Internal Administration of Arsenic in Canker and other Diseases of the Foot in Horses, by J. D. E. HOLMES, M.A., D.Sc., M.R.C.V.S. Price, As. 2 or 3*d.*

No. 33. Some Aspects of the Agricultural Development of Bihar, by ALBERT HOWARD, M.A., A.R.C.S., F.L.S. Price, As. 4 or 5*d.*

No. 34. Diseases of Rice, by E. J. BUTLER, M.B., F.L.S. Price, As. 8 or 9*d.*

No. 35. Report on the Flax Experiments conducted at Dooriah during the year 1912-13, by E. M. VANDEKERKHOVE. Price, As. 3 or 4*d.*

No. 36. Note on the M'Fadyean Staining Reaction for Anthrax Bacilli, by J. D. E. HOLMES, M.A., D.Sc., M.R.C.V.S. Price, As. 4 or 5*d.*

No. 37. Notes on Experiments with Sugarcane at Sabour, by C. SOMERS-TAYLOR, B.A. Price, As. 2 or 3*d.*

No. 38. Disintegration of Rice Grains by means of Alkali, by F. J. WARTH, M.Sc.; and D. B. DARABSETT, B.Sc. Price, As. 6 or 7*d.*

No. 39. Instructions for rearing Mulberry Silkworms, by M. N. DE. Second (Revised Edition.) Price, As. 8 or 9*d.*

No. 40. Green-Manuring Experiment, 1912-13, by C. M. HUTCHINSON, B.A.; and S. MILLIGAN, M.A., B.Sc. Price, As. 4 or 5*d.*

No. 41. The use of Sweet Jowar (*Sorghum* sp.) as a source of Commercial Sugar or as Fodder and the variation in Composition of the crop during growth, by H. E. ANNETT, B.Sc., F.I.C. Price, As. 2 or 3*d.*

No. 42. Notes on Cane Crushing in the United Provinces, by G. CLARKE, F.I.C.; NAIB HUSSAIN and S. C. BANERJEE, assisted by LAKSHMI SHANKAR. Price, As. 2 or 3*d.*

No. 43. A Note on 'the Effect of Heat on the Rinderpest Immune Bodies, by J. D. E. HOLMES, C.I.E., M.A., D.Sc., M.R.C.V.S. Price, As. 2 or 3*d.*

No. 44. How to Improve Silk-Reeling in Bengal, by M. N. DE. Price, As. 4 or 5*d.*

No. 45. The Acid Secretion of the Gram Plant (*Cicer arietinum*), by D. L. SAHASRABUDDHE, B.Sc., L.Ag. Price, As. 2 or 3*d.*

No. 46. Bee-Keeping, by C. C. GHOSH, B.A. Price, As. 14 or 1*s.* 4*d.*

No. 47. Notes on Sugar Machinery and Manufacture in Northern India, 1914, by PETER ABEL. Price, As. 5 or 6*d.*

BULLETINS ISSUED BY THE AGRICULTURAL RESEARCH INSTITUTE, PUSA—*concld.*

No. 48. First Report on the Experiments carried out at Pusa to improve the Mulberry Silk Industry, compiled under the direction of the Imperial Entomologist, by M. N. De. Price, As. 6 or 7*d.*

No. 49. The Experimental Error in Field Trials with Sugarcane and the effect on this error of various methods of sampling, by H. E. Annett, B.Sc., F.I.C. Price, As. 3 or 4*d.*

No. 50. The Improvement of Tobacco Cultivation in Bihar, by Albert Howard, C.I.E., M.A.; and Gabrielle L. C. Howard, M.A. Price, As. 4 or 5*d.*

No. 51. First Report on the Improvement of Indigo in Bihar with notes on Drainage and on Green Manuring by Albert Howard, C.I.E., M.A.; and Gabrielle L. C. Howard, M.A. Price, As. 4 or 5*d.*

No. 52. Soil Ventilation, by Albert Howard, C.I.E., M.A.; and Gabrielle L. C. Howard, M.A. (Second Edition.) Price, As. 8 or 9*d.*

No. 53. Soil Erosion and Surface Drainage, by Albert Howard, C.I.E., M.A. (Second Edition.) Price, As. 8 or 9*d.*

No. 54. Second Report on the Improvement of Indigo in Bihar, by Albert Howard, C.I.E., M.A.; and Gabrielle L. C. Howard, M.A. Price, As. 2 or 3*d.*

No. 55. The Manufacture of Jaggery in South India, by A. Chatterton, C.I.E. Price, As. 4 or 5*d.*

No. 56. Green-Manuring in India, by A. C. Dobbs. Price, As. 6 or 7*d.*

No. 57. The Detection of Added Water in Milk in India, by J. Walter Leather, V.D., F.I.C. Price, As. 2 or 3*d.*

No. 58. *Calocoris angustatus*, Leth., by E. Ballard, B.A., F.E.S. Price, As. 4 or 5*d.*

No. 59. One hundred Notes on Indian Insects, by T. Bainbrigge Fletcher, F.L.S., F.E.S., F.Z.S. Price, As. 8 or 9*d.*

No. 60. A comparison of the "Defibrination" and "Oxalate" methods of serum preparation as applied to Hæmorrhagic Septicæmia and Anthrax Sera, together with some analyses of Buffalo and Hill Bull blood, by R. V. Norris, M.Sc., D.Sc. Price, As. 3 or 4*d.*

No. 61. Soil Aeration in Agriculture, by Albert Howard, C.I.E., M.A. Price, As. 4 or 5*d.*

No. 62. A Preliminary Chemical Study of the Rices of Bihar and Orissa, by Jatindra Nath Sen, M.A., F.C.S. Price, As. 4 or 5*d.*

No. 63. A Modified Method of Green-Manuring, by C. M. Hutchinson, B.A. Price, As. 2 or 3*d.*

No. 64. Rinderpest—Preparation of Anti-serum, by A. W. Shilston, M.R.C.V.S. (*In the press.*)

No. 65. A Study in the Assimilation of Nutrients by the Rice Plant, by Jatindra Nath Sen, M.A., F.C.S. Price, As. 2 or 3*d.*

No. 66. Berseem as a new fodder crop for India, by G. S. Henderson, N.D.A., N.D.D. Price, As. 3 or 4*d.*

No. 67. Third Report on the Improvement of Indigo in Bihar, by Albert Howard, C.I.E., M.A.; and Gabrielle L. C. Howard, M.A. Price, As. 4 or 5*d.*

No. 68. Saltpetre—Its origin and extraction in India, by C. M. Hutchinson, B.A. (*In the press.*)

BOOKS.

"Indian Insect Pests," by H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S. Price, Re. 1-8. (*Out of print.*)

"Indian Insect Life," by H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S.; and F. M. Howlett, B.A. 786 pp. Price, Rs. 20 or 30*s.* (*Out of print.*)

"Wheat in India," by Albert Howard, M.A., A.R.C.S., F.L.S.; and Gabrielle L. C. Howard, M.A. 288 pp. Price, Rs. 5 or 7*s.* 6*d.*

"A description of the Imperial Bacteriological Laboratory, Muktesar: Its Work and Products," by Major J. D. E. Holmes, M.A., D.Sc., M.R.C.V.S. Price, As. 8 or 9*d.*

"Agriculture in India," by James Mackenna, M.A., I.C.S. Price, As. 4 or 5*d.*

"Some Diseases of Cattle in India, 1916." A hand-book for stock-owners. Price, As. 8 or 9*d.*